14290Z

Remedial Investigation/Feasibility Study Phase I Technical Memorandum

Appendices A-C,E-M

Waukegan Manufactured Gas and Coke Plant Site
Waukegan, Illinois

Prepared for
North Shore Gas Company

Under the Administrative Order on Consent Re: Remedial Investigation and Feasibility Study for the Waukegan Manufactured Gas and Coke Plant Site Waukegan, Illinois

April 1993

Engineering Company

Remedial Investigation/Feasibility Study Phase I Technical Memorandum

Appendices A-C, E-M

Waukegan Manufactured Gas and Coke Plant Site
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April 1993

Barr
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Minneapolis, MN 55437
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Appendices

DOCUMENT CONTENTS

Appendix A

Test Trench Logs

TEST PIT WALL LOG

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-00B SHEET 1 OF 1

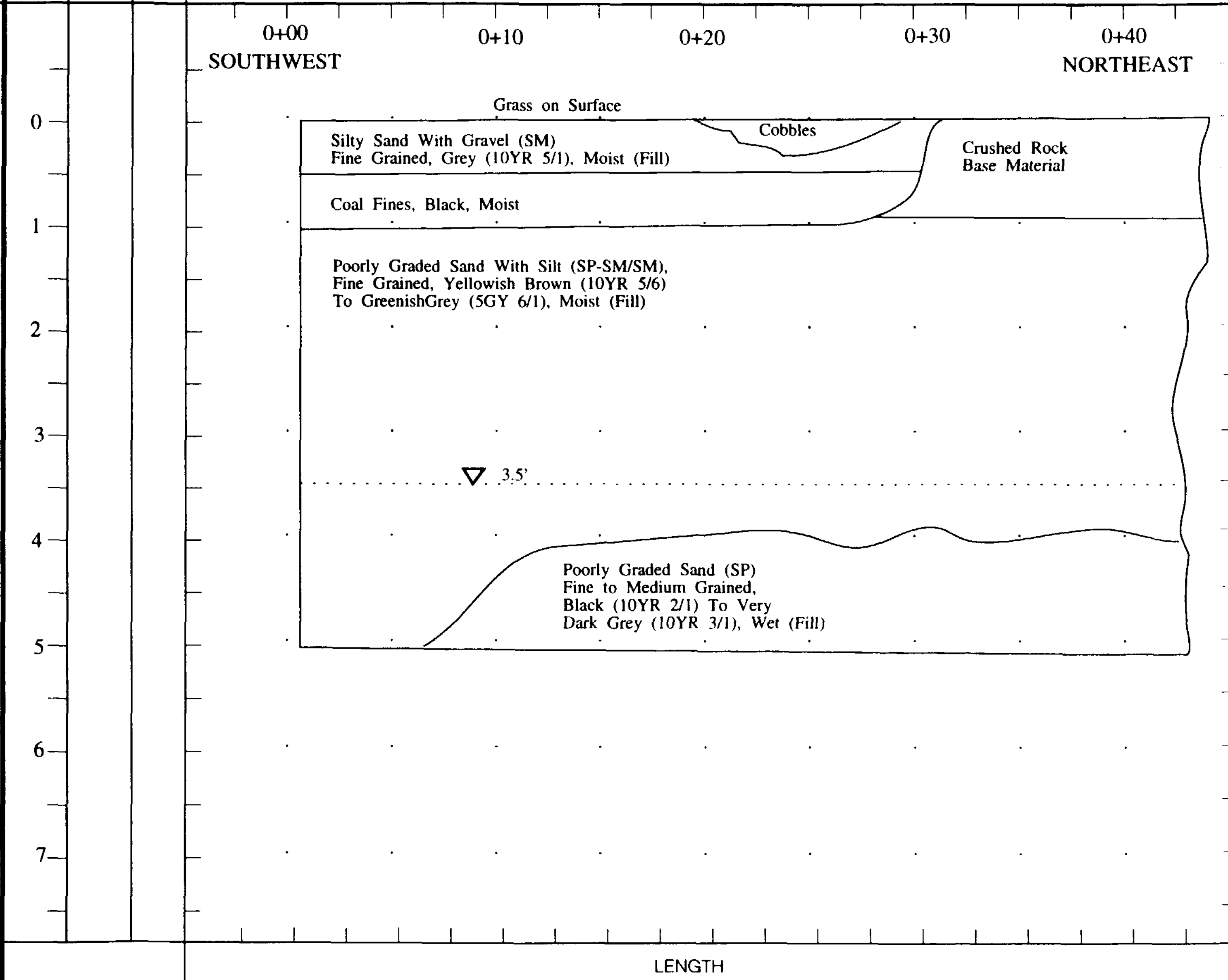
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NW WALL OF PIT

ELEVATION CONTRACTOR Kirshoffer DATE EXCAVATED 3/11/92

WATER LEVEL AND DATE EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 50' WIDTH 3-4' DEPTH 5' REMARKS

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

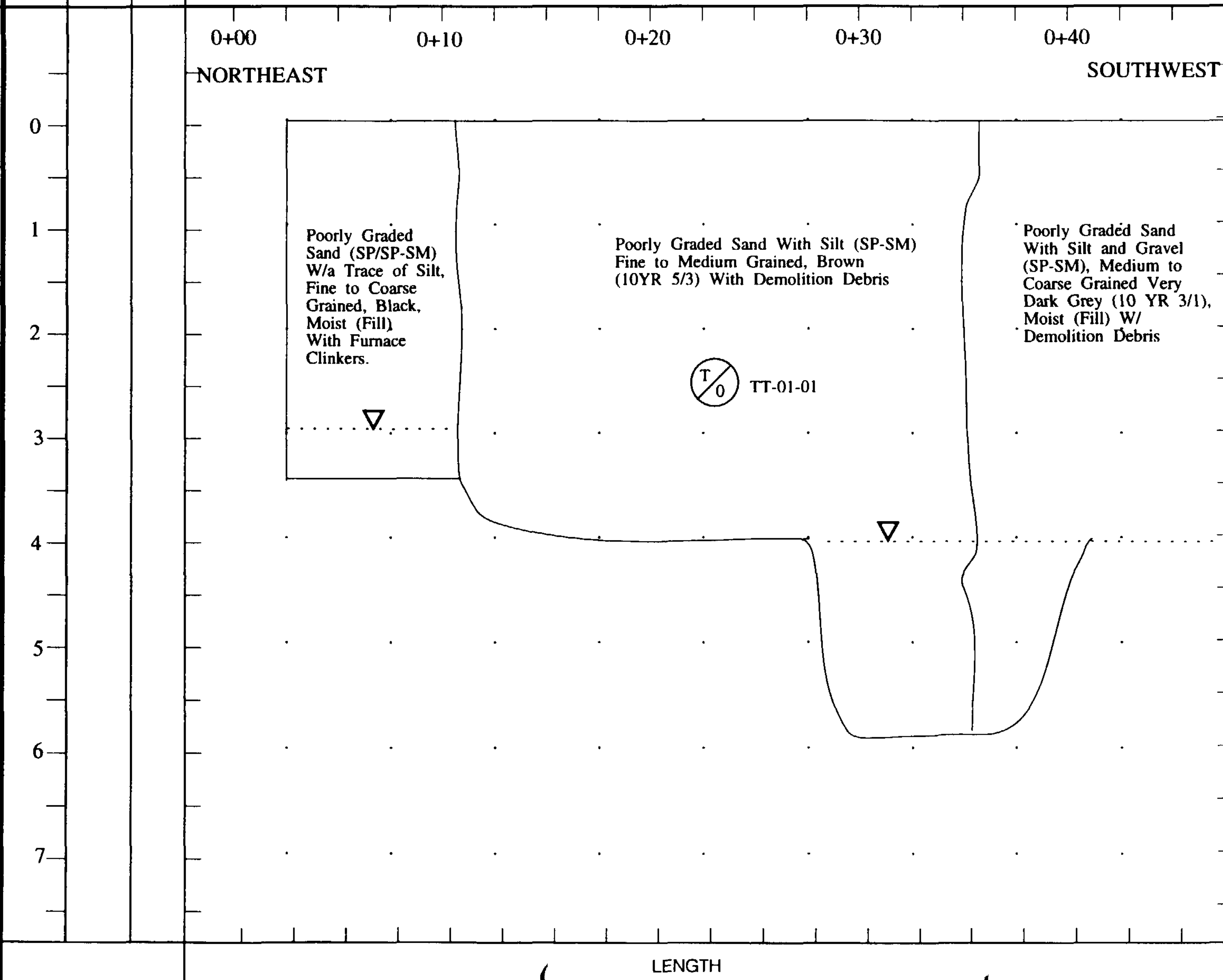
No Sheen on Groundwater

TEST PIT WALL LOG

PROJECT NO. 13/49-003JSL
TEST PIT NO. TT-01 SHEET 1 OF 5

PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NW WALL OF PIT
ELEVATION ______ CONTRACTOR Kirshhoffer DATE EXCAVATED 3-6-92
WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER SEM
APPROXIMATE DIMENSIONS LENGTH 220' WIDTH 3-4' DEPTH 1 - 6 1/2' REMARKS ______

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE TYPE AND NUMBER	SAMPLE INTERVAL



COMMENTS

Spoon Test Location and Result:

M/10

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

Headspace Reading, ppm

Moderate To Heavy Sheen on Groundwater

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-01 SHEET 2 OF 5	**TEST PIT WALL LOG**

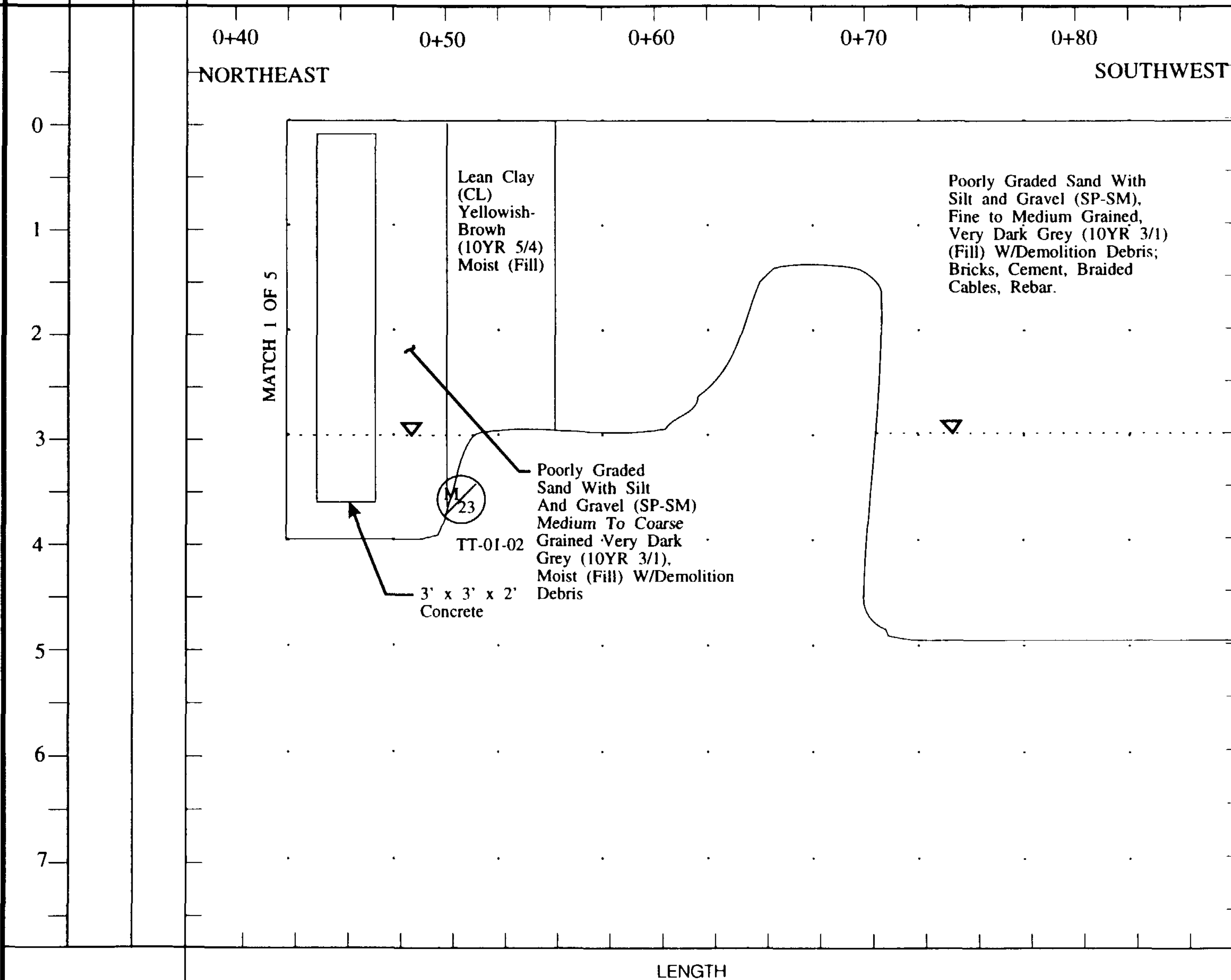
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NW WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshhoffer DATE EXCAVATED 3-9-92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER SEM

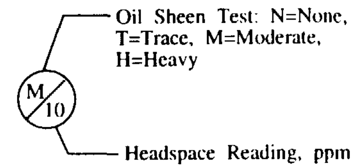
APPROXIMATE DIMENSIONS LENGTH 220' WIDTH 3-4' DEPTH 1 - 6 1/2' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:



PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-01 SHEET 3 OF 5	

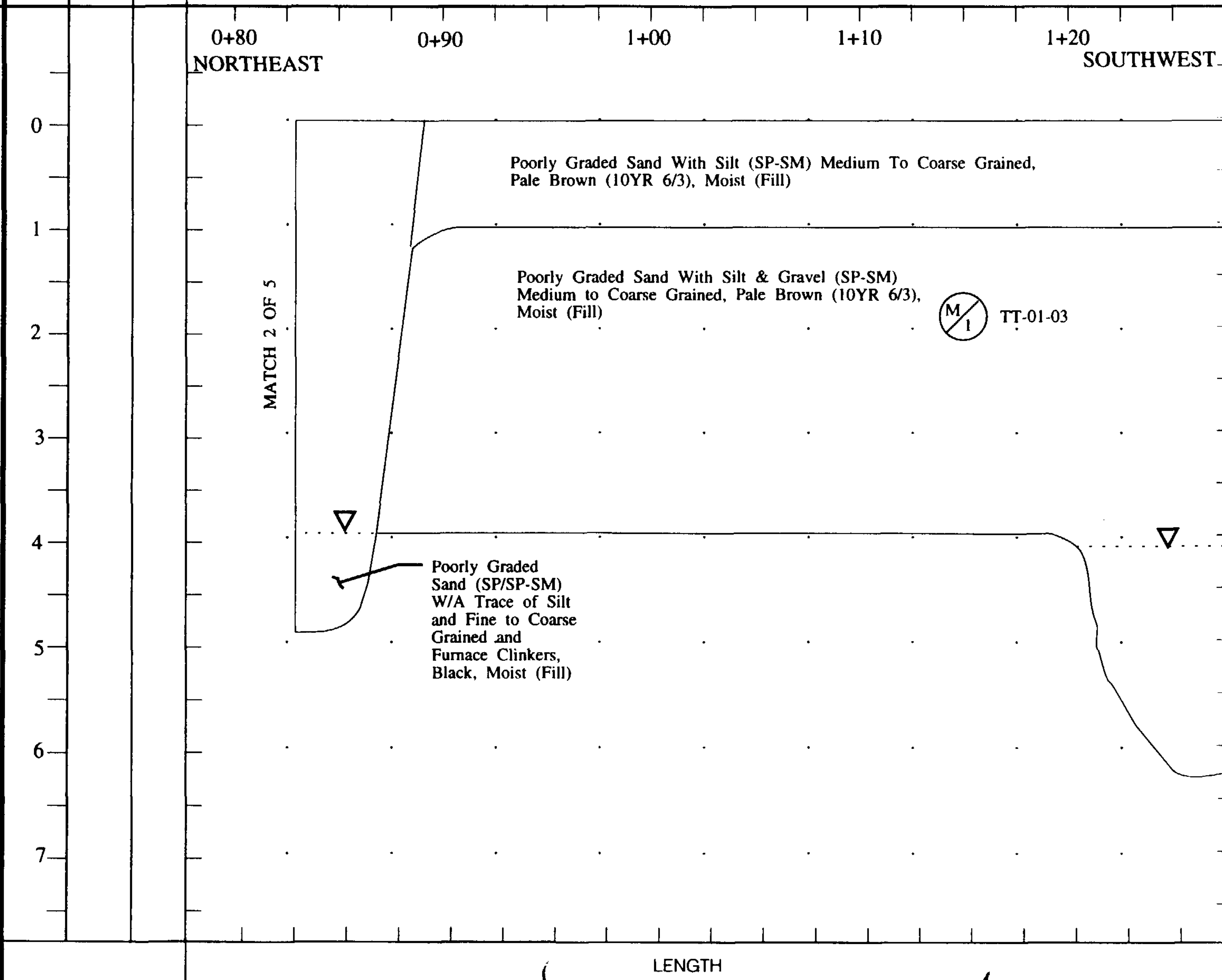
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NW WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshhoffer DATE EXCAVATED 3-6-92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 220' WIDTH 3-4' DEPTH 1 - 6 1/2' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Moderate Sheen on Groundwater

PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-01 SHEET 4 OF 5	

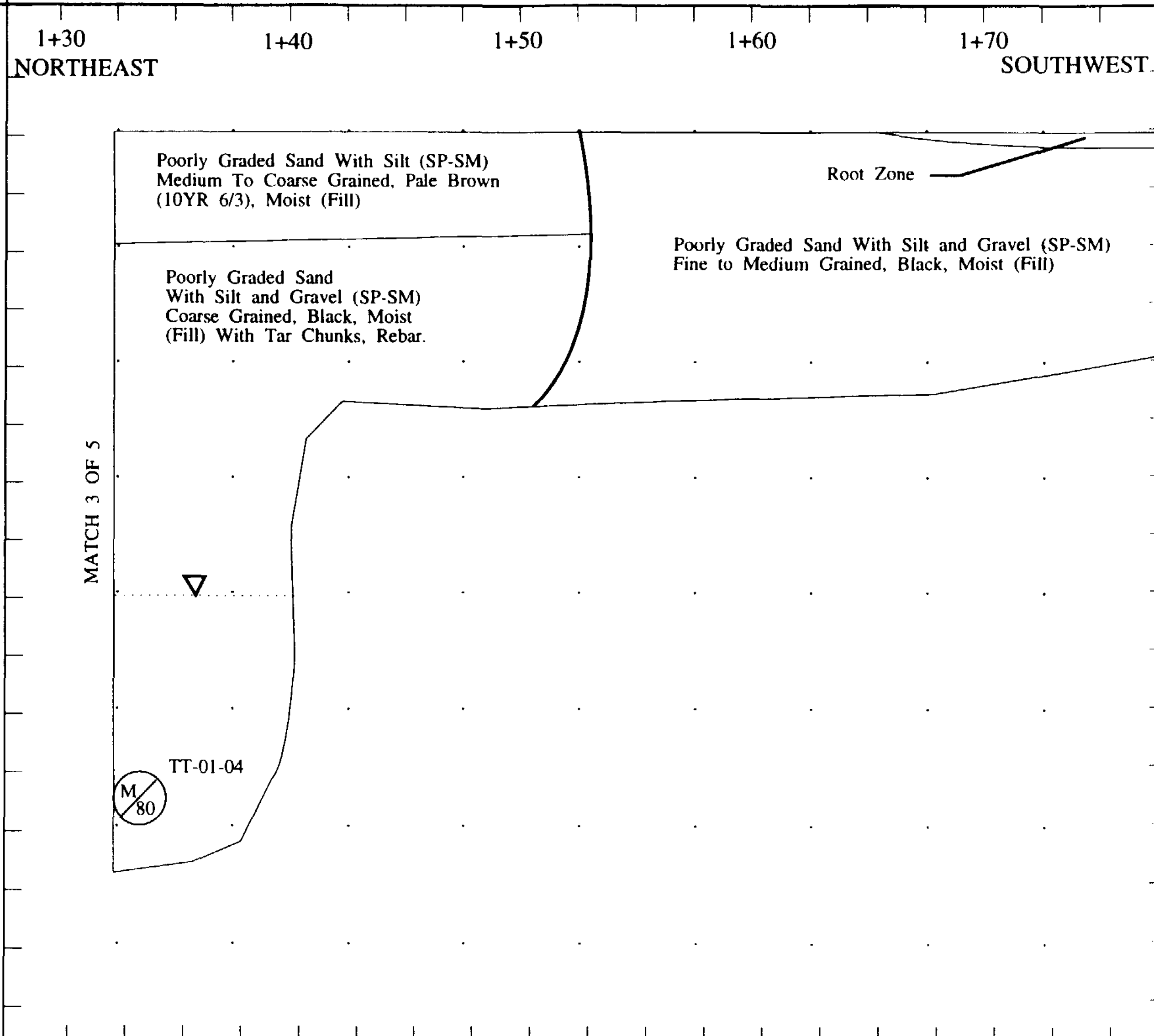
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NW WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshhoffer DATE EXCAVATED 3-6-92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER SEM

APPROXIMATE DIMENSIONS LENGTH 220' WIDTH 3-4' DEPTH 1-6 1/2' REMARKS ______

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE TYPE AND NUMBER	SAMPLE INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



LENGTH

COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

TEST PIT WALL LOG

PROJECT NO.	TEST PIT NO.	SHEET	OF
13/49-003JSL	TT-01	5	5

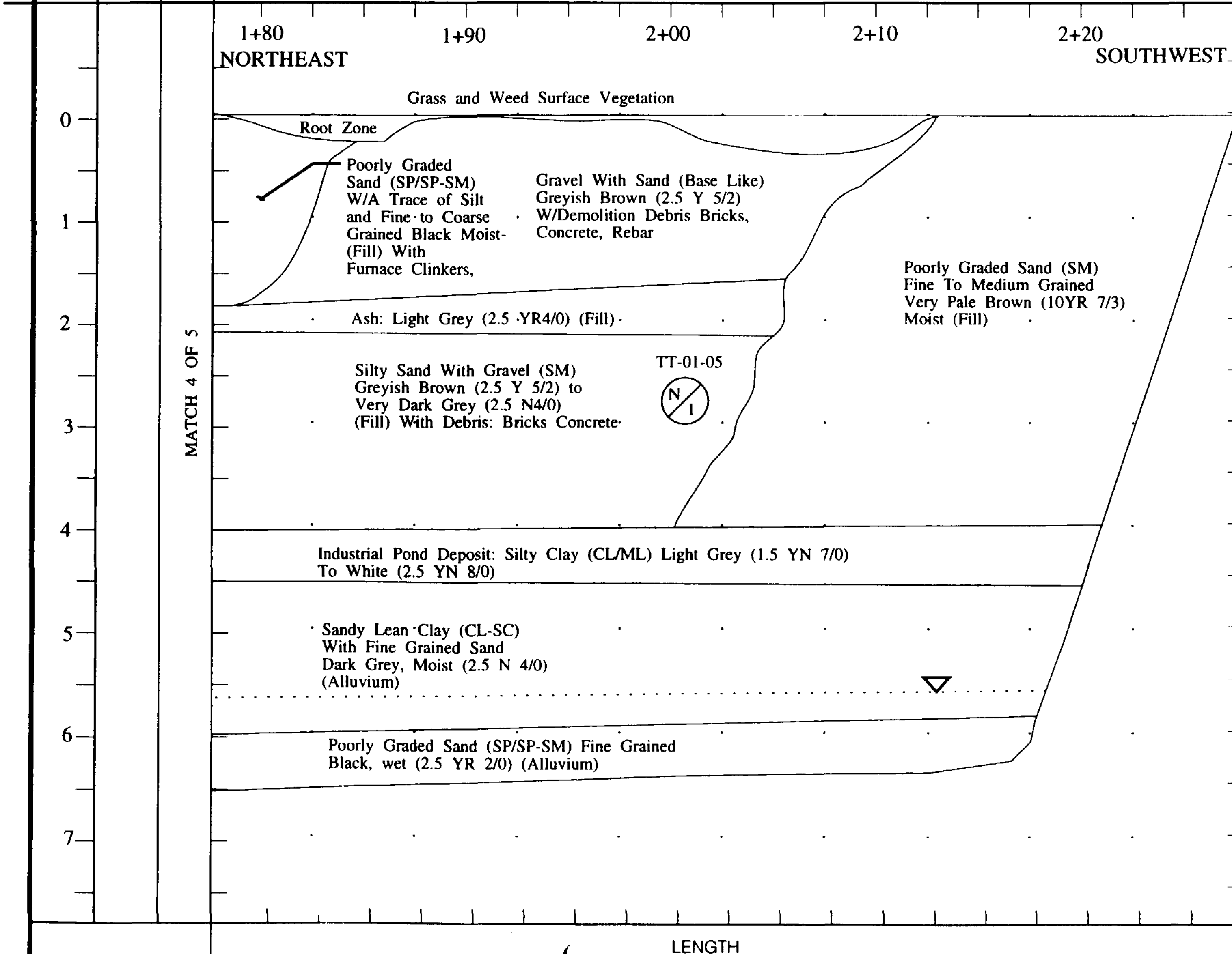
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NW WALL OF PIT

ELEVATION CONTRACTOR Kirshhoffer DATE EXCAVATED 3-9-92

WATER LEVEL AND DATE EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 220' WIDTH 3-4' DEPTH 1 - 6 1/2' REMARKS

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER, INTERVAL



COMMENTS

Spoon Test Location and Result:

M / 10

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

Headspace Reading, ppm

Moderate Sheen on Groundwater

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-02 SHEET 1 OF 5	TEST PIT WALL LOG

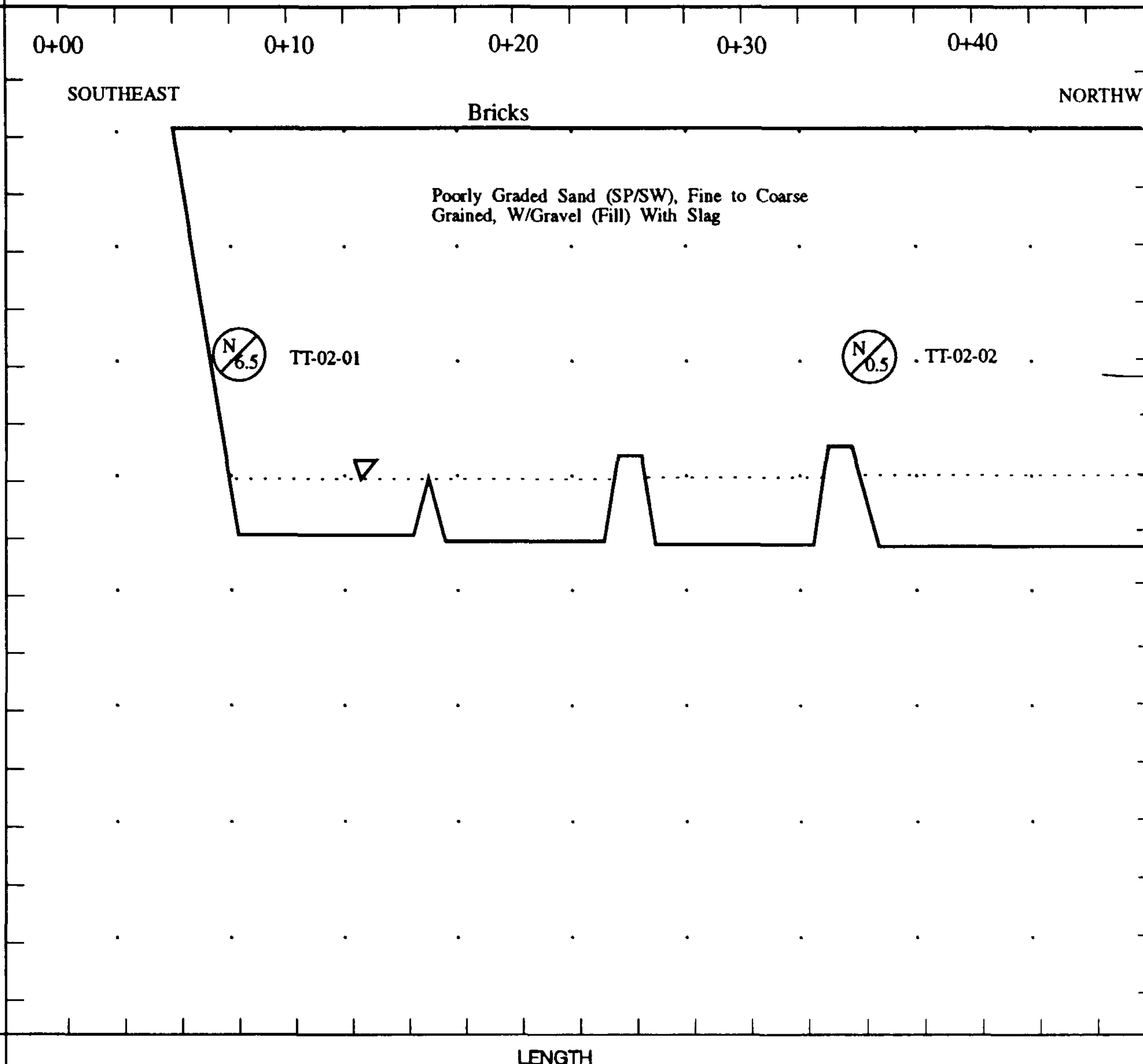
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NE WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/5/92

WATER LEVEL AND DATE 3' EXCAVATION METHOD B-Hoe LOGGER SEM

APPROXIMATE DIMENSIONS LENGTH 185' WIDTH 3-4' DEPTH 3-3.5' REMARKS ______

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE TYPE AND NUMBER	SAMPLE INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M 10

Headspace Reading, ppm

Trace Sheen on Groundwater Between 0+24 and 0+33NW.

Moderate Sheen on Groundwater Between 0+35 and 0+4NW.

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-02 SHEET 2 OF 5	TEST PIT WALL LOG

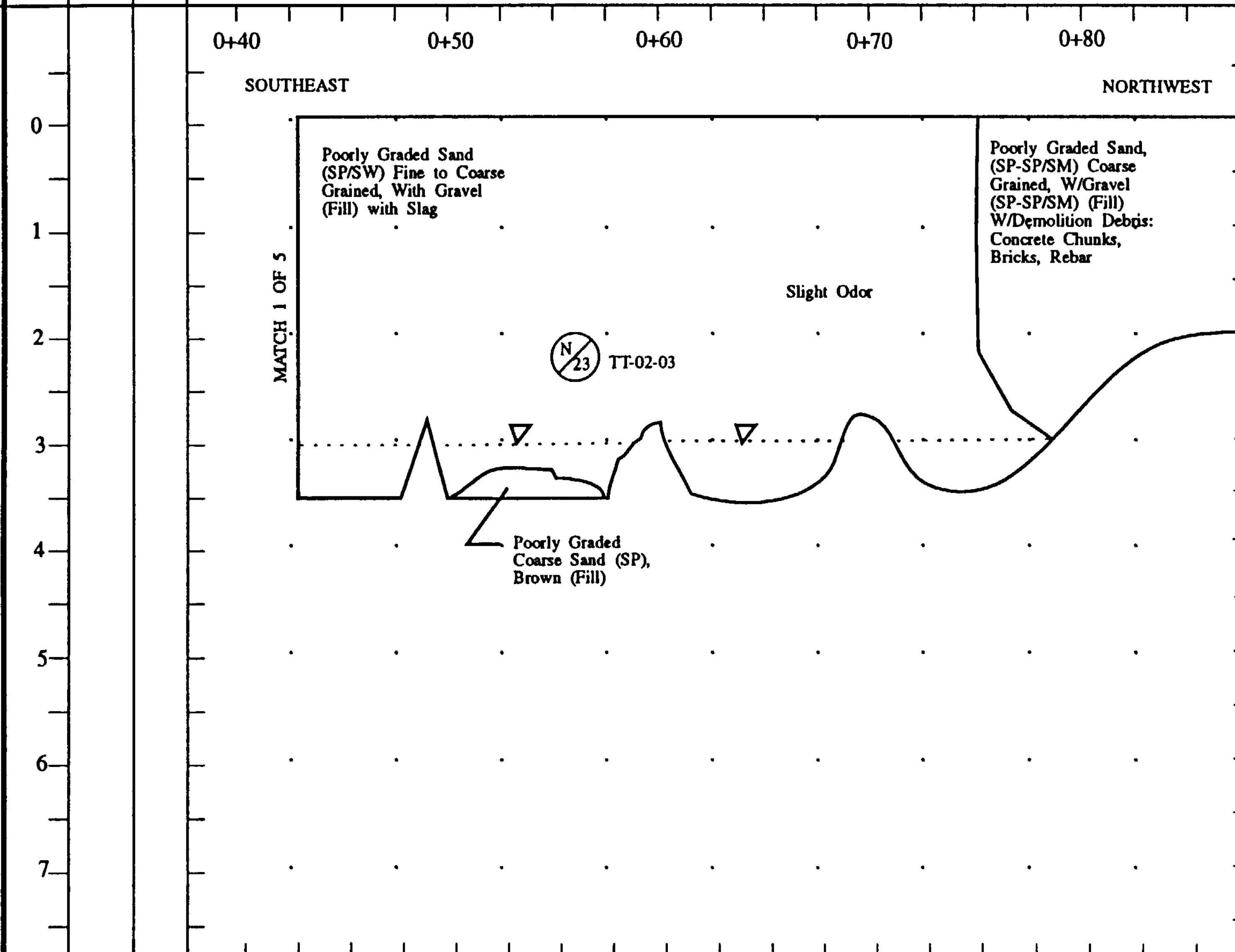
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NE WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/5/92

WATER LEVEL AND DATE 3' EXCAVATION METHOD B-Hoe LOGGER SEM

APPROXIMATE DIMENSIONS LENGTH 185' WIDTH 3-4' DEPTH 3-3.5' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



LENGTH

COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Moderate Sheen on Groundwater Between 0+60 and 0 +70 NW

TEST PIT WALL LOG

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-02 SHEET 3 OF 5

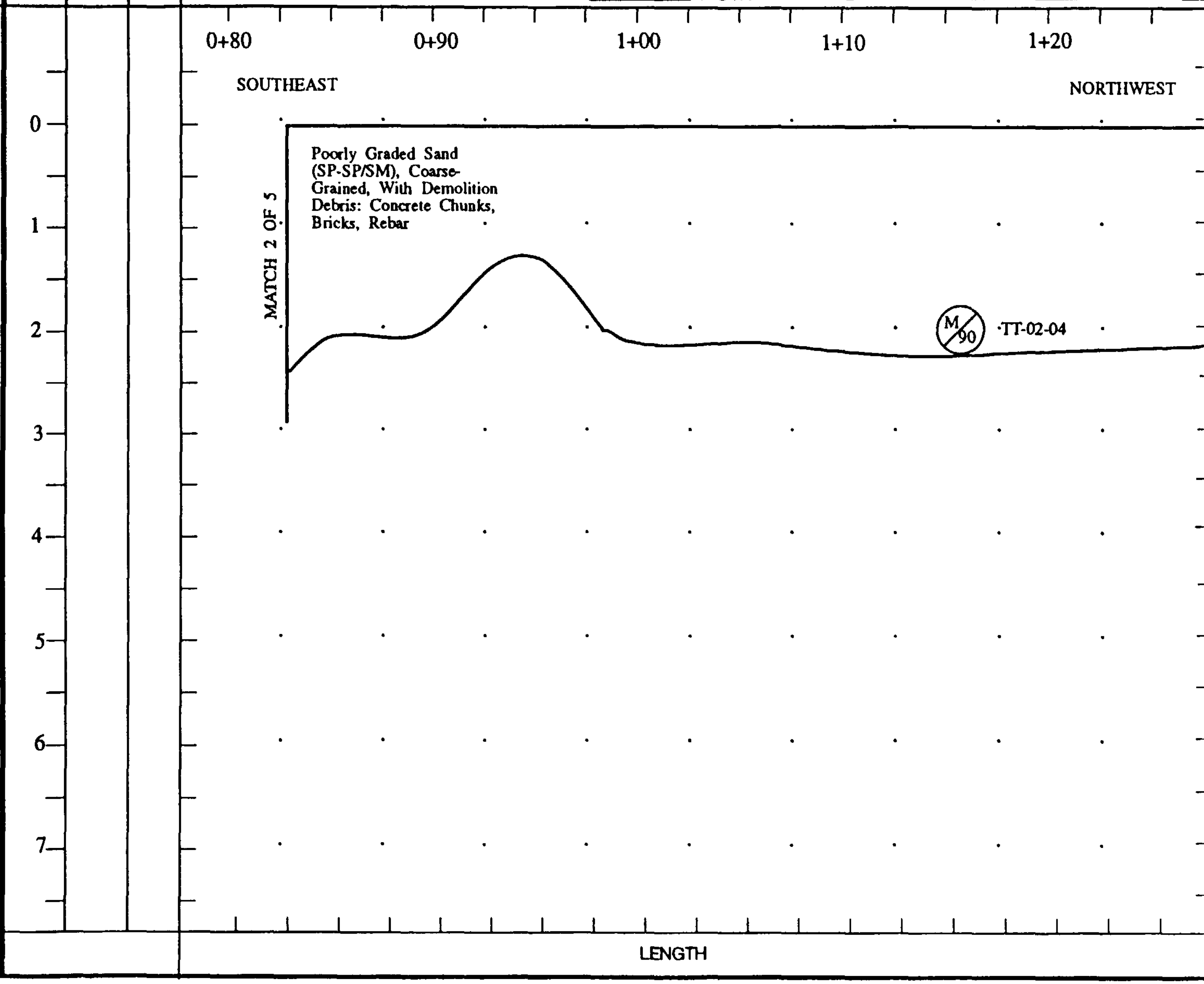
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NE WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/5/92

WATER LEVEL AND DATE 3' EXCAVATION METHOD B-Hoe LOGGER SEM

APPROXIMATE DIMENSIONS LENGTH 185' WIDTH 3-4' DEPTH 3-3.5' REMARKS ______

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE: TYPE AND NUMBER	SAMPLE: INTERVAL



COMMENTS

Spoon Test Location and Result:

M / 10

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

Headspace Reading, ppm

TEST PIT WALL LOG

PROJECT NO.	TEST PIT NO.	SHEET	OF
13/49-003JSL	TT-02	4	5

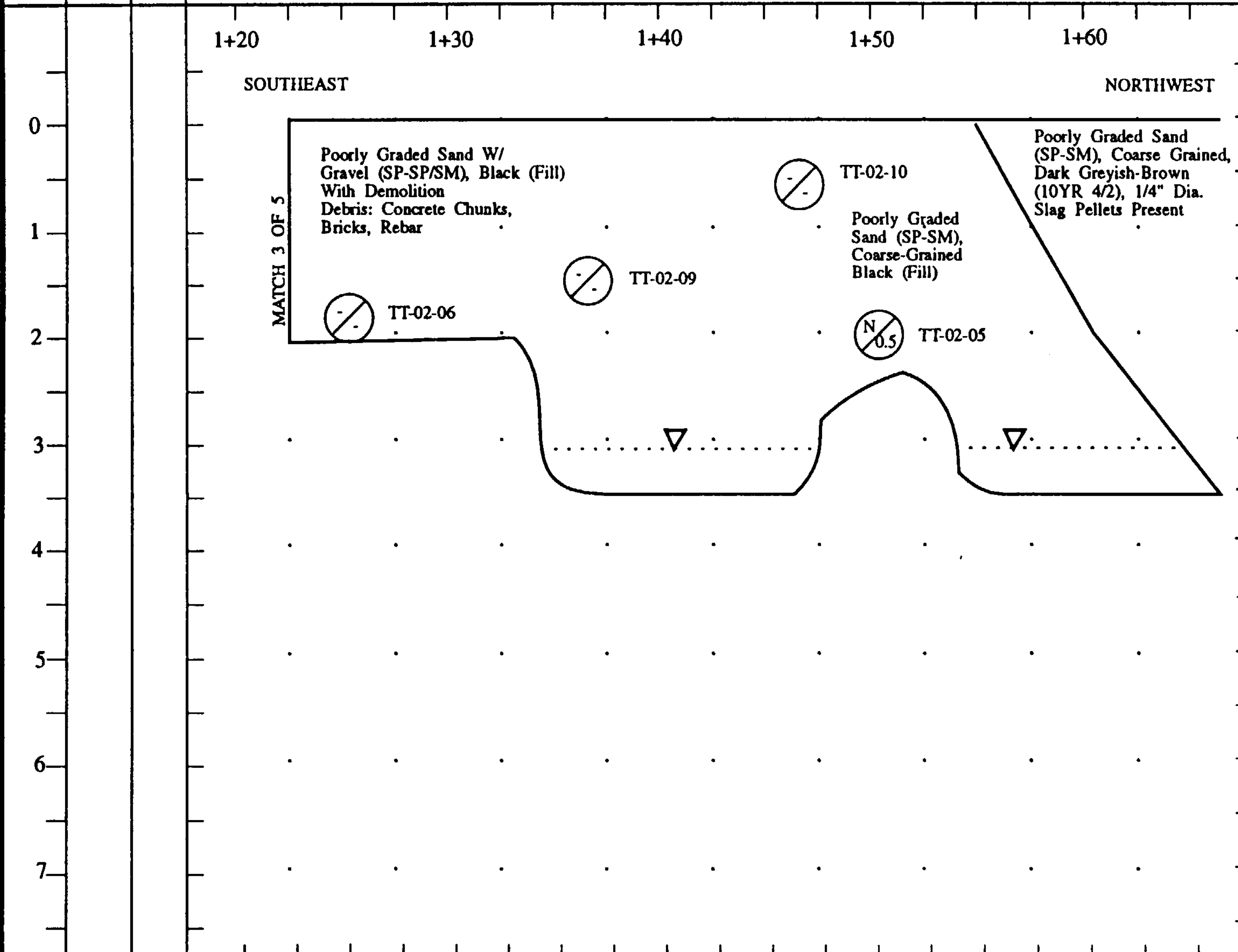
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NE WALL OF PIT

ELEVATION CONTRACTOR Kirshoffer DATE EXCAVATED 3/5/92

WATER LEVEL AND DATE 3' EXCAVATION METHOD B-Hoe LOGGER SEM

APPROXIMATE DIMENSIONS LENGTH 185' WIDTH 3-4' DEPTH 3-3.5' REMARKS

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



LENGTH

COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M 10

Headspace Reading, ppm

Moderate Sheen on Groundwater Between 1+35 and 1+68 NW Streaks Present.

Heavy Sheen on Groundwater Between 1+53 and 1+68 NW Blotches present.

TEST PIT WALL LOG

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-02 SHEET 5 OF 5	TEST PIT WALL LOG

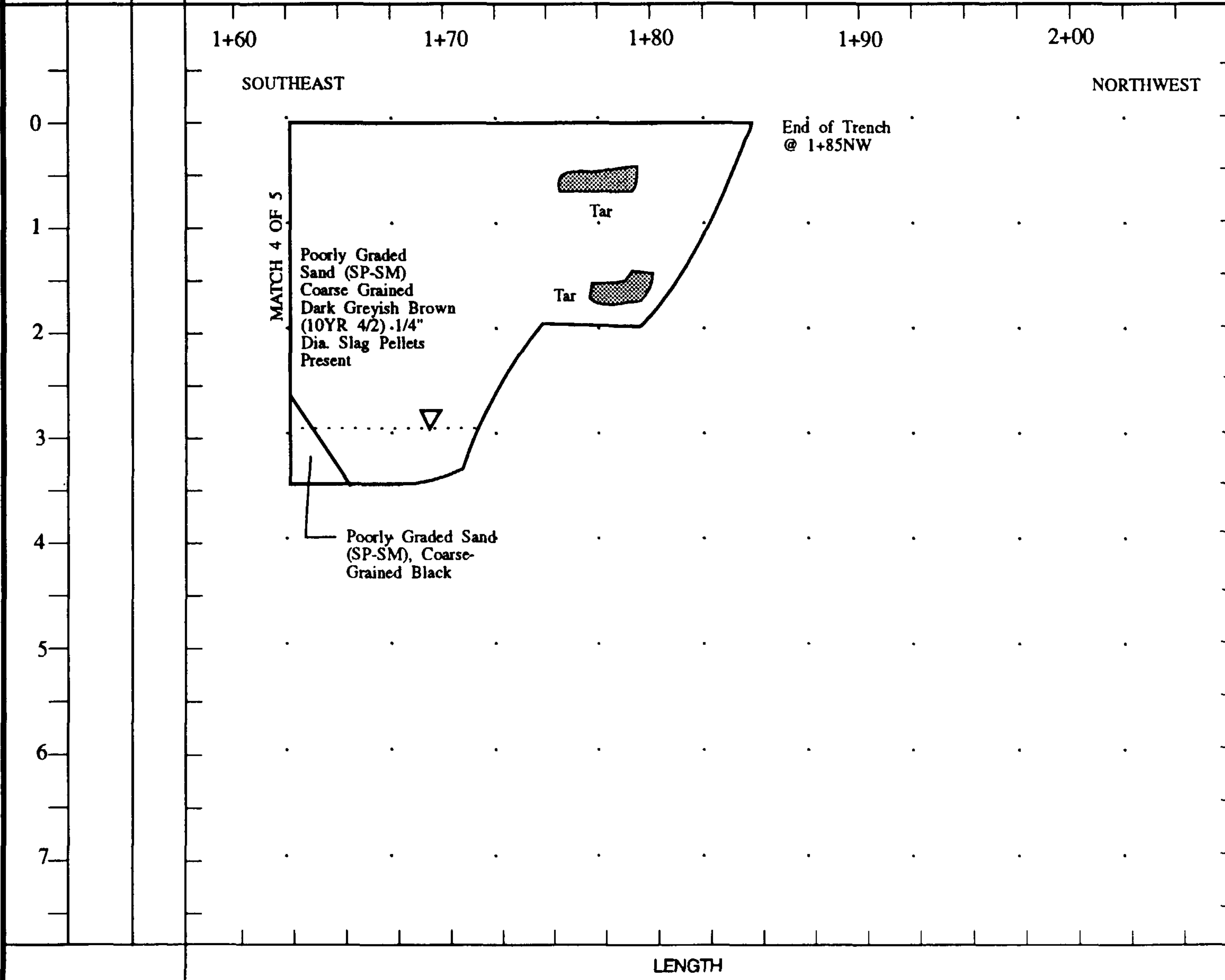
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NE WALL OF PIT

ELEVATION CONTRACTOR Kirshoffer DATE EXCAVATED 3/5/92

WATER LEVEL AND DATE 3' EXCAVATION METHOD B-Hoe LOGGER SEM

APPROXIMATE DIMENSIONS LENGTH 185' WIDTH 3-4' DEPTH 3-3.5' REMARKS

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE: TYPE AND NUMBER	SAMPLE: INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

This log is "Backwards" -Stationing was from Right to Left.

Heavy Sheen on Groundwater Between 1+53 and 1+68 NW Blotches present.

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-03 SHEET 1 OF 5	TEST PIT WALL LOG

PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF W WALL OF PIT

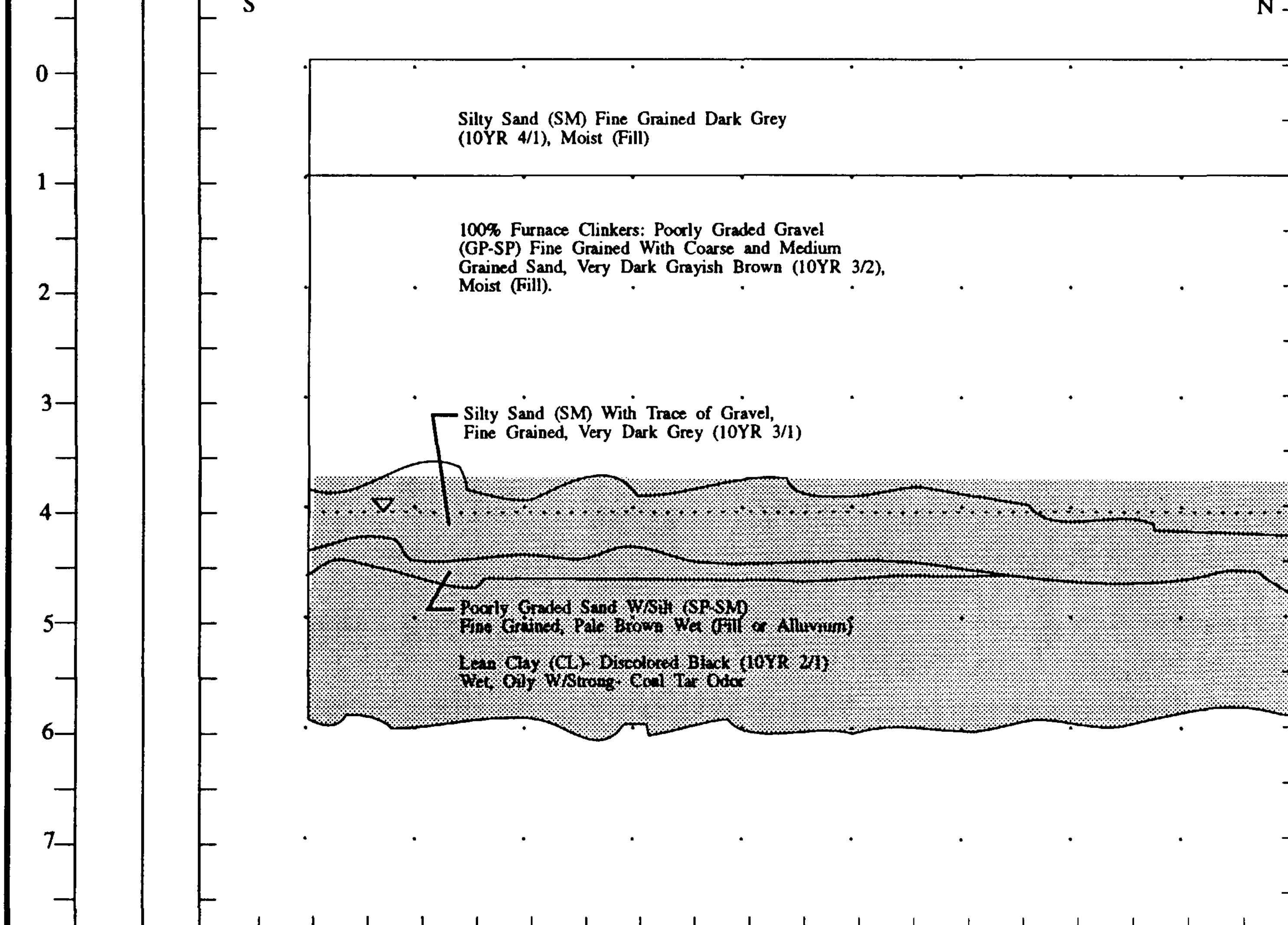
ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3-10-92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 185 WIDTH 3-4' DEPTH 6' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL

S 0+00 0+10 0+20 0+30 0+40 N



LENGTH

COMMENTS

Tar, Tar in Pore Spaces of Soil

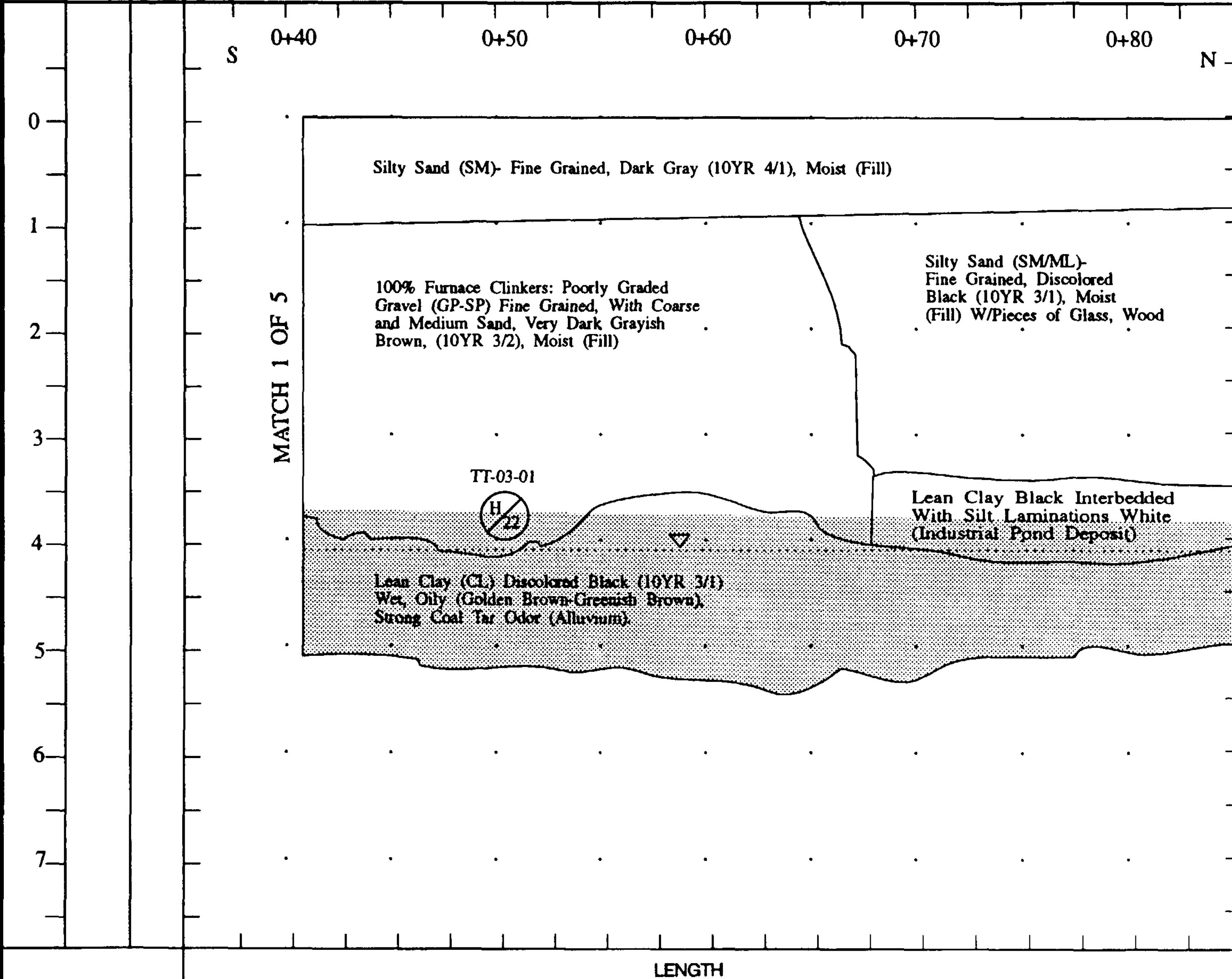
Oil in Pore Spaces of Soil

Heavy Rainbow Sheen on Groundwater

TEST PIT WALL LOG

PROJECT NO.	13/49-003JSL
TEST PIT NO.	TT-03
SHEET	2 OF 5
PROJECT	Northshore Gas Waukegan Coke Plant
LOCATION	Waukegan, IL.
MAP OF	W WALL OF PIT
ELEVATION	
CONTRACTOR	Kirshoffer
DATE EXCAVATED	3-10-92
WATER LEVEL AND DATE	
EXCAVATION METHOD	B-Hoe
LOGGER	JMF
APPROXIMATE DIMENSIONS	LENGTH 185 WIDTH 3-4' DEPTH 5'
REMARKS	

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER, INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Rainbow Sheen On Groundwater W/Golden Brown Oily Blebs

PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-03 SHEET 3 OF 5	

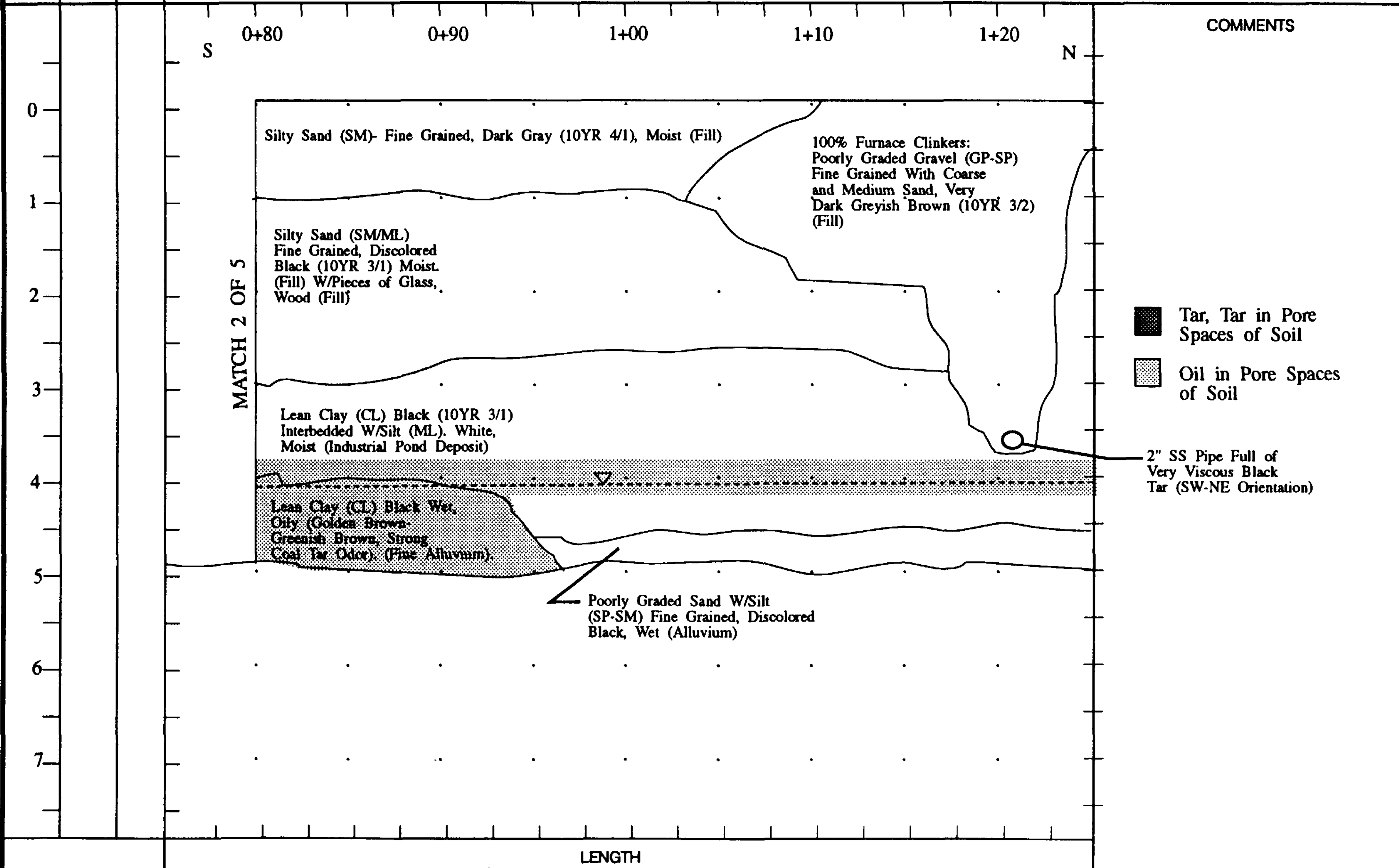
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF W WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3-10-92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 185 WIDTH 3-4' DEPTH 5' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



TEST PIT WALL LOG

PROJECT NO.	TEST PIT NO.	SHEET	OF
13/49-003JSL	TT-03	4	5

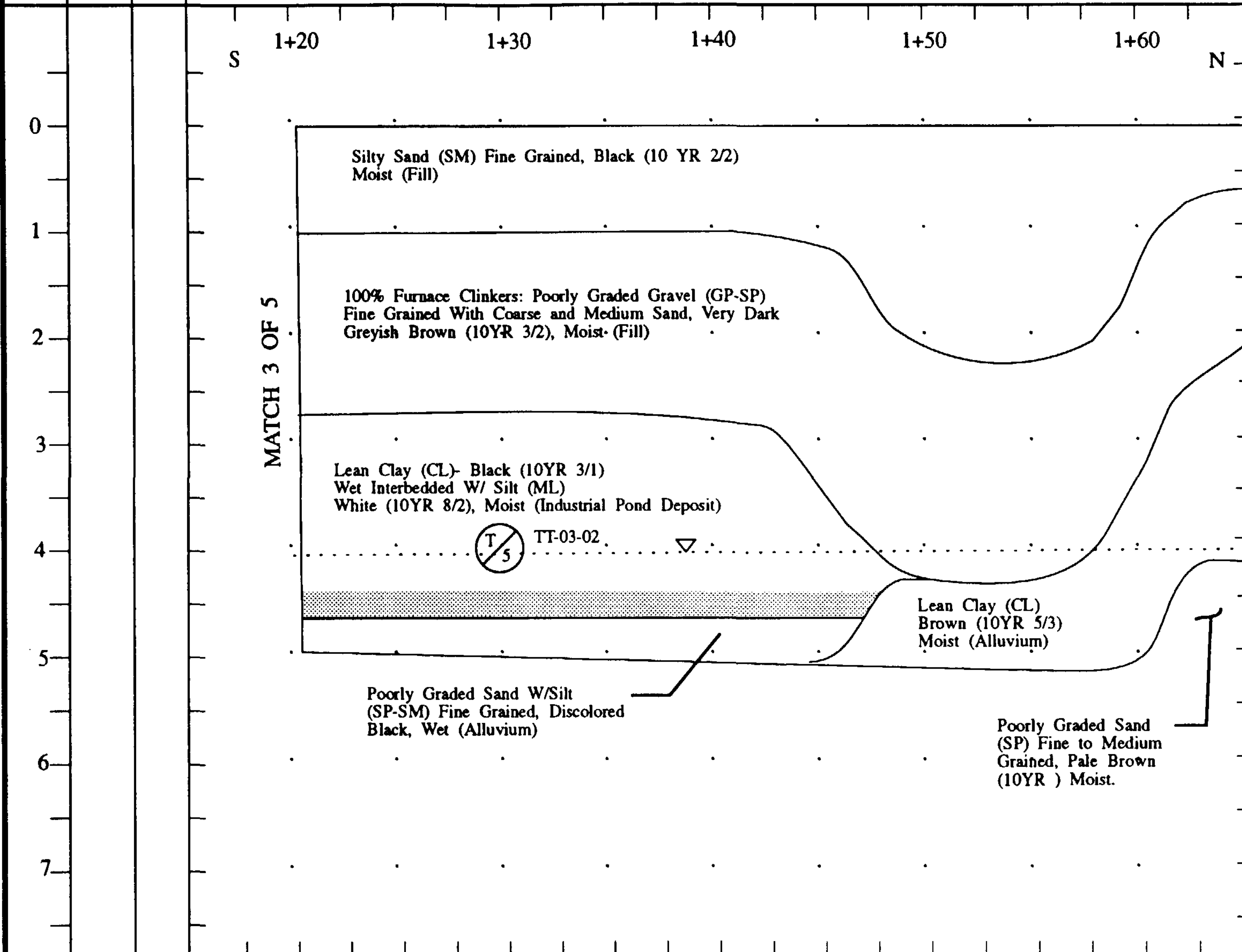
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF W WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/10/92-3/11/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 185 WIDTH 3-4' DEPTH 6' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

M/10 — Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy; Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

TEST PIT WALL LOG

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-03 SHEET 5 OF 5

PROJECT Northshore Gas Waukegan Coke Plant

LOCATION Waukegan, IL.

MAP OF W WALL OF PIT

ELEVATION

CONTRACTOR Kirshoffer

DATE EXCAVATED 3/11/92

WATER LEVEL AND DATE

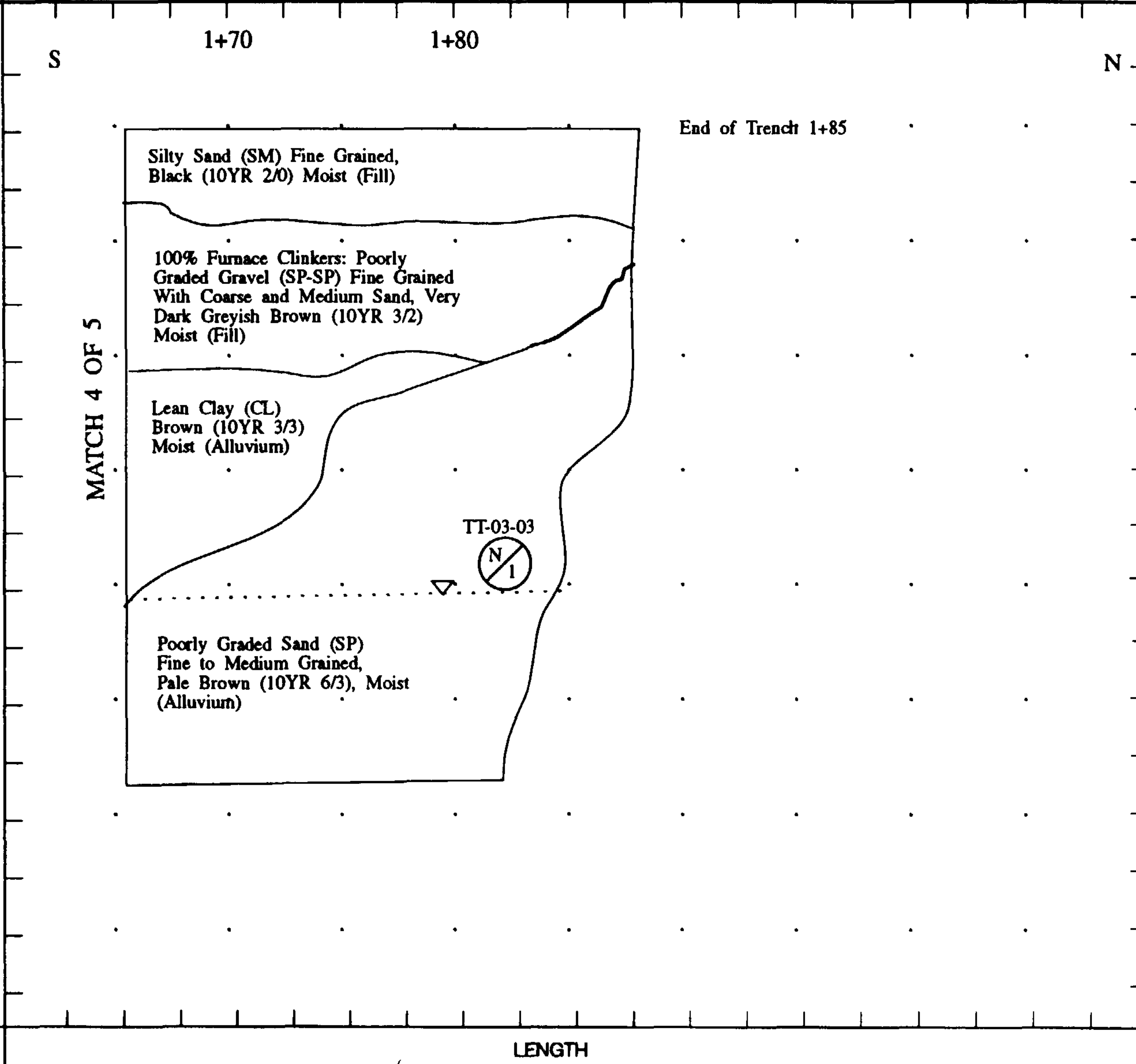
EXCAVATION METHOD B-Hoe

LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 185 WIDTH 3-4' DEPTH 6'

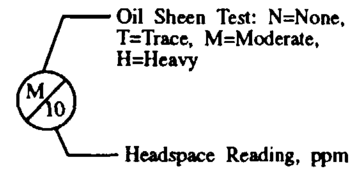
REMARKS

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE: TYPE AND NUMBER	SAMPLE: INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



COMMENTS

Spoon Test Location and Result:



PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-03W SHEET 1 OF 5	

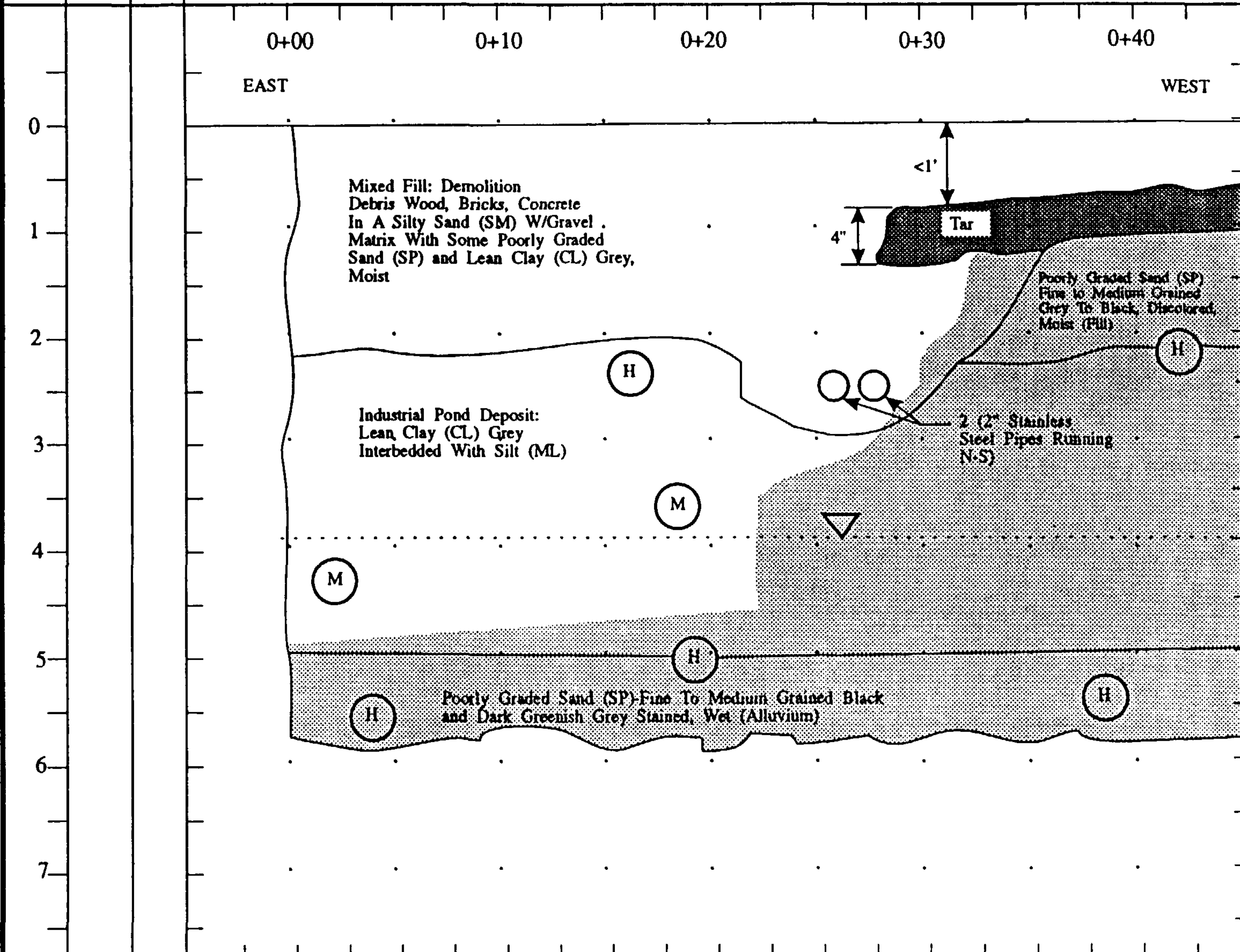
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/13/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 210 WIDTH 3-4' DEPTH 5-6' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



LENGTH

COMMENTS

Spoon Test Location and Result:

- N None
- T Trace
- M Moderate
- H Heavy

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Oil Sheen on Groundwater W/ Golden Brown- Green Oily Blebs

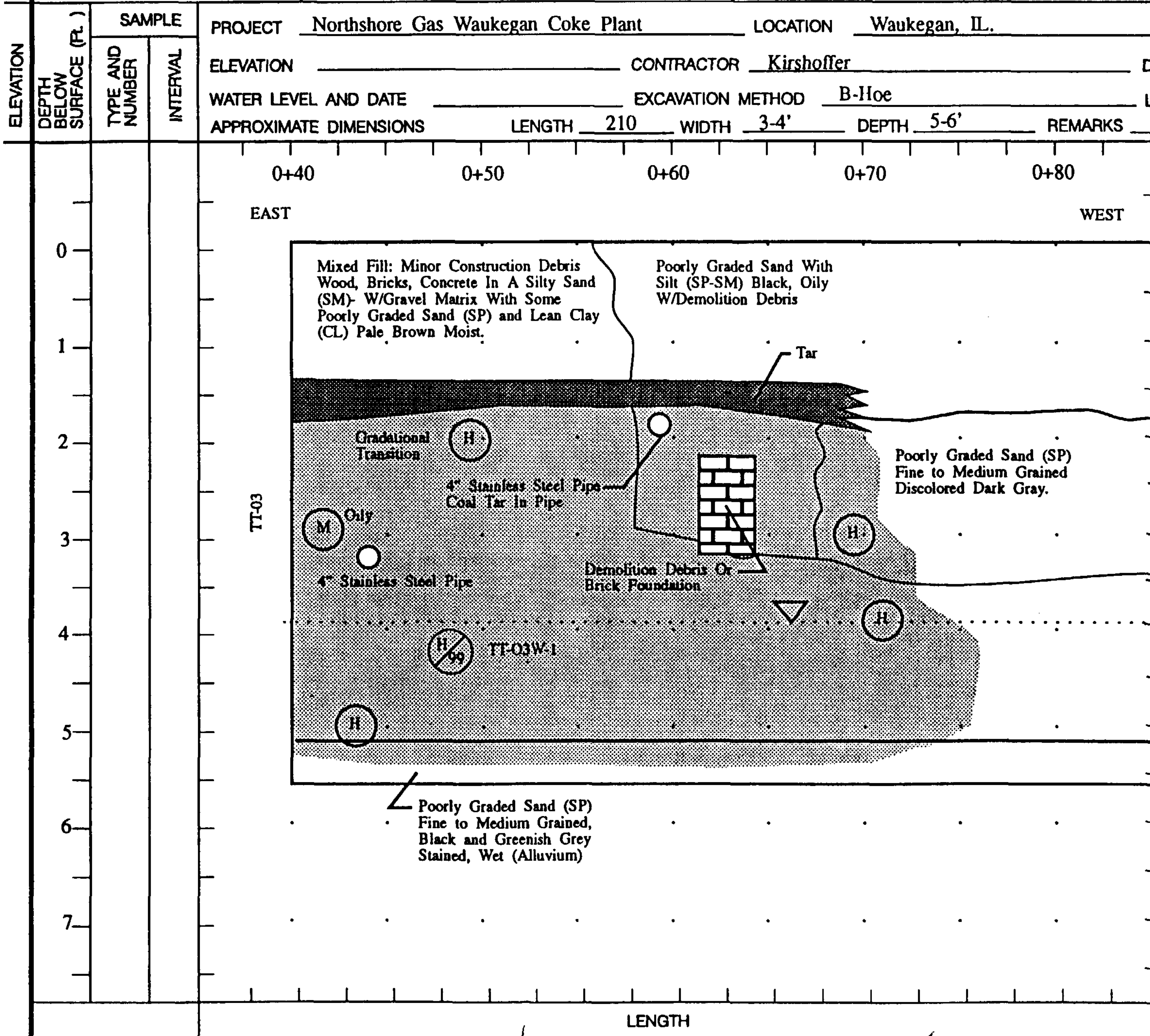
PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-03W SHEET 2 OF 5	

PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/13/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 210 WIDTH 3-4' DEPTH 5-6' REMARKS ______



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Spoon Test Location and Result:

- N None
- T Trace
- M Moderate
- H Heavy

Heavy Oil Sheen on Groundwater With a Trace of Golden Brown Oily Blebs

- Tar, Tar in Pore Spaces of Soil
- Oil in Pore Spaces of Soil

PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-03W SHEET 3 OF 5	

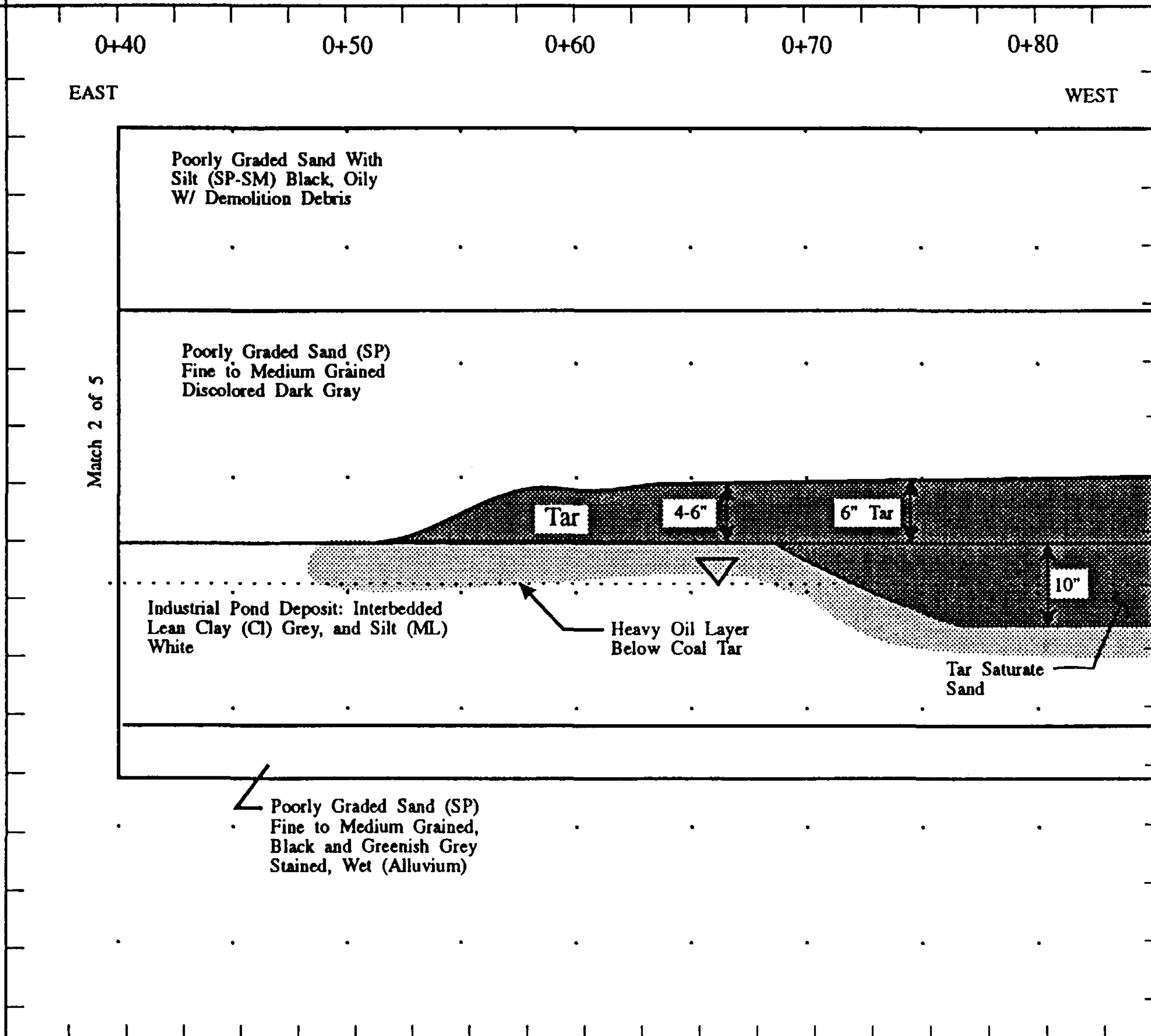
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/13/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 210 WIDTH 3-4' DEPTH 5-6' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Spoon Test Location and Result:

(N) None

(T) Trace

(M) Moderate

(H) Heavy

Groundwater @ 3.8' With Heavy Rainbow Sheen and Golden Brown Oily Blebs

Pore Spaces Filled W/Oil In Zone Directory Below Coal Tar, Sand Laminations In Pond Deposit and Sand @ Base of Trench.

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

PROJECT NO.	TEST PIT NO.	
13/49-003JSL	TT-03W SHEET 4 OF 5	**TEST PIT WALL LOG**

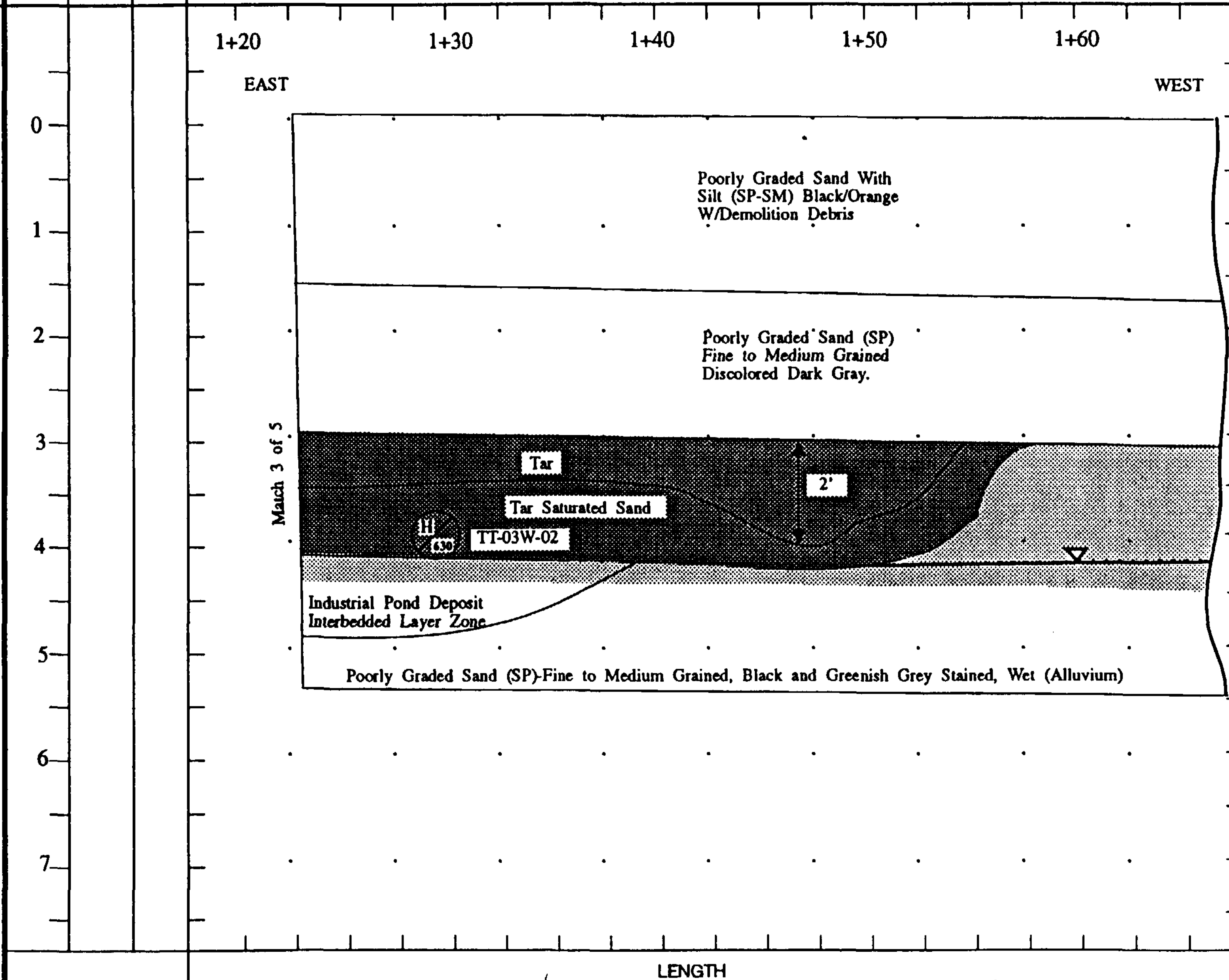
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/13/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 210 WIDTH 3-4' DEPTH 5-6' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

End Of Trench @ 1+70'

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Groundwater @ 4' W/Heavy Rainbow Sheen Oily Blebs.

Porespaces Filled W/Oil: Oily Zone @ Base Of Coal Tar Saturated Sand and in Sand Below and In Interbedded Layer

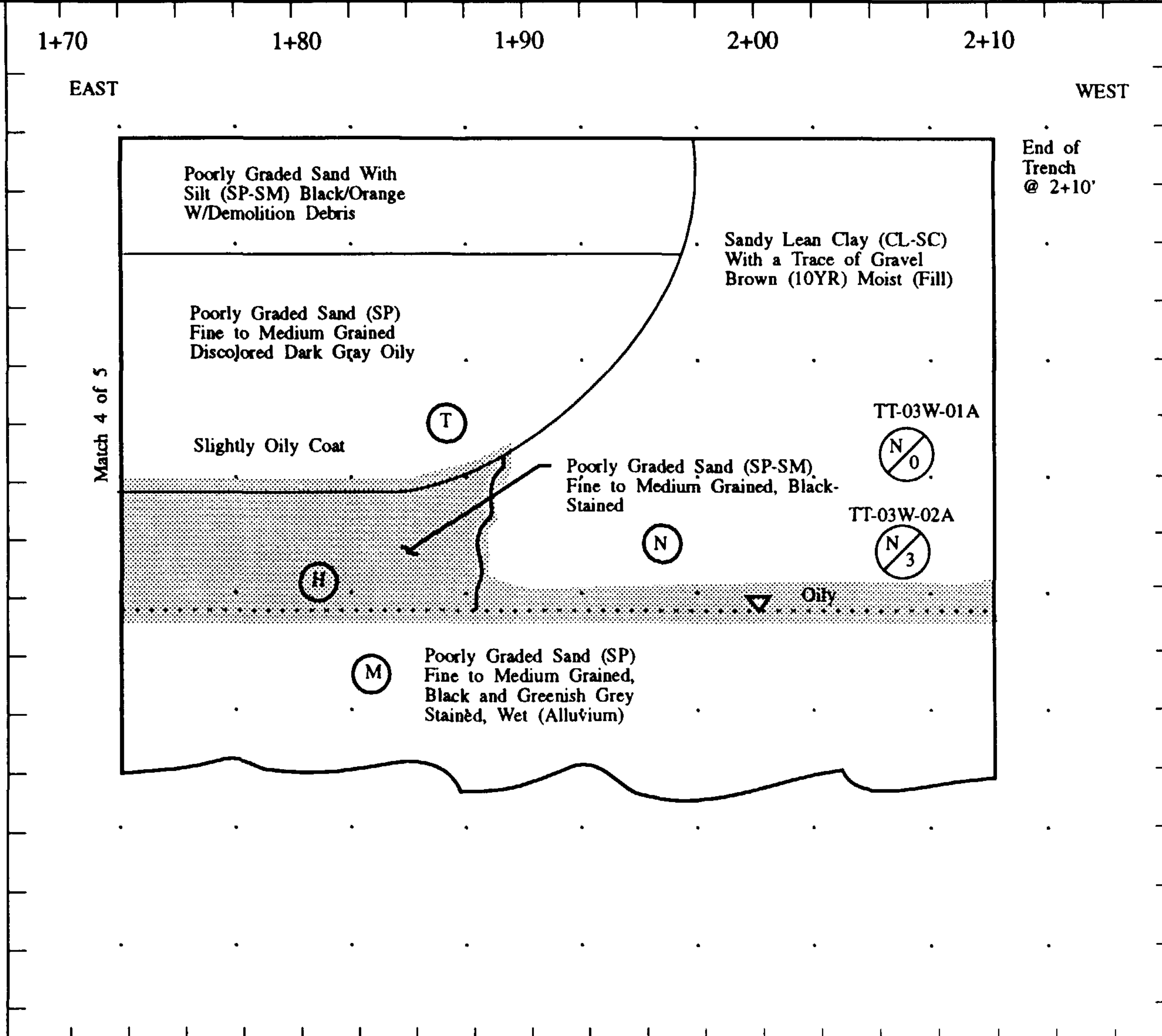
PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-03W SHEET 5 OF 5

TEST PIT WALL LOG

PROJECT	Northshore Gas Waukegan Coke Plant
LOCATION	Waukegan, IL.
MAP OF	S WALL OF PIT
ELEVATION	
CONTRACTOR	Kirshoffer
DATE EXCAVATED	3/13/92
WATER LEVEL AND DATE	
EXCAVATION METHOD	B-Hoe
LOGGER	JMF
APPROXIMATE DIMENSIONS	LENGTH 210 WIDTH 3-4' DEPTH 5-6'
REMARKS	

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



LENGTH

COMMENTS

Spoon Test Location and Result:

M/10 — Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy; Headspace Reading, ppm

Spoon Test Location and Result:

- N - None
- T - Trace
- M - Moderate
- H - Heavy

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Groundwater @ 4' W/Moderate Oil Sheen

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-04 SHEET 1 OF 1	TEST PIT WALL LOG

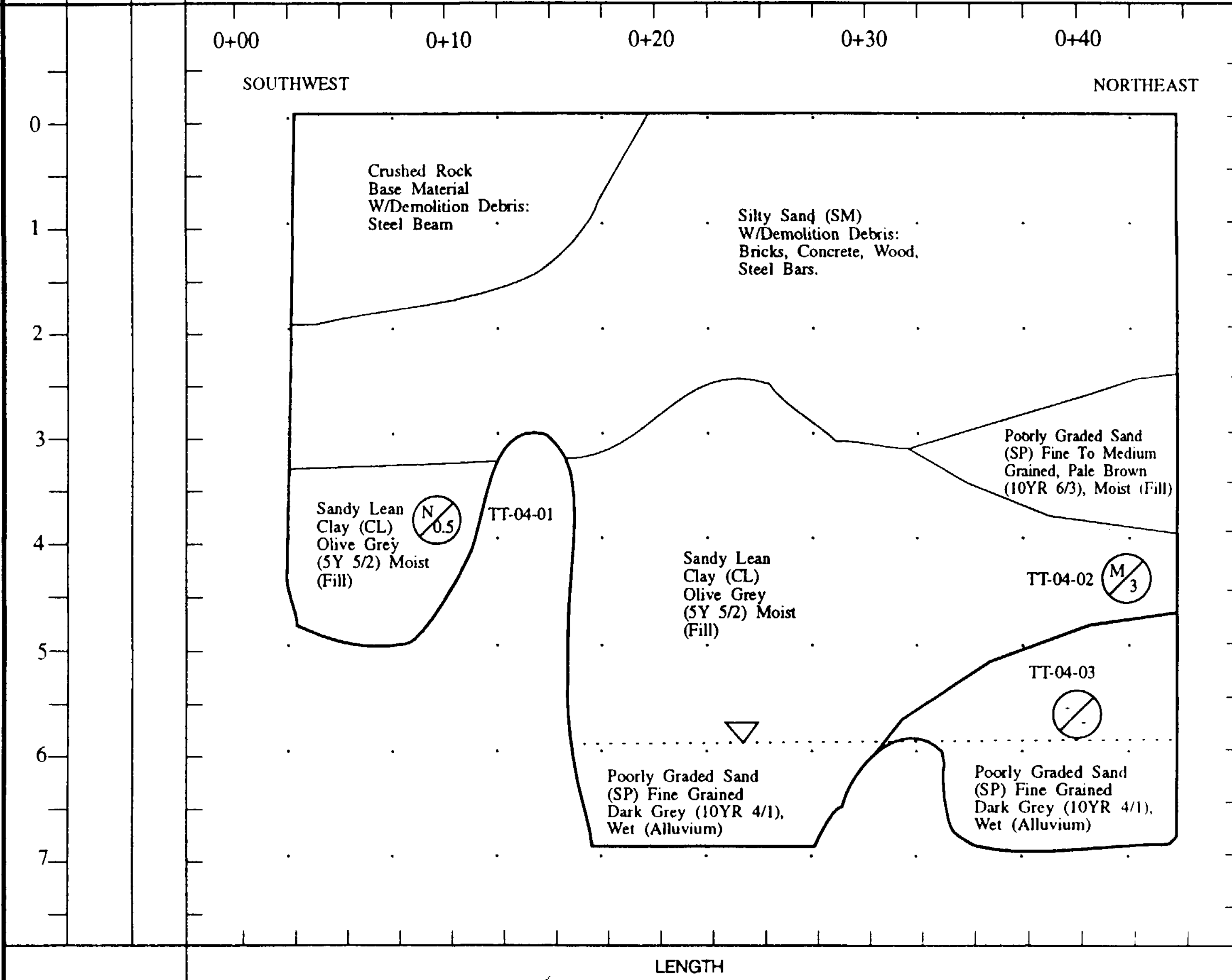
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NW WALL OF PIT

ELEVATION ____ CONTRACTOR Kirshoffer DATE EXCAVATED 3/5/92

WATER LEVEL AND DATE ____ EXCAVATION METHOD B-Hoe LOGGER SEM

APPROXIMATE DIMENSIONS LENGTH 45 WIDTH 3-4' DEPTH 3-7' REMARKS ____

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

End of Trench @ 0 +45

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M 10

Headspace Reading, ppm

Moderate Sheen On Ground Water 0+00 to 0+25; Heavy Sheen 0+25 to End of Trench.

PROJECT NO.	TEST PIT NO.	
13/49-003JSL	TT-05 SHEET 1 OF 2	**TEST PIT WALL LOG**

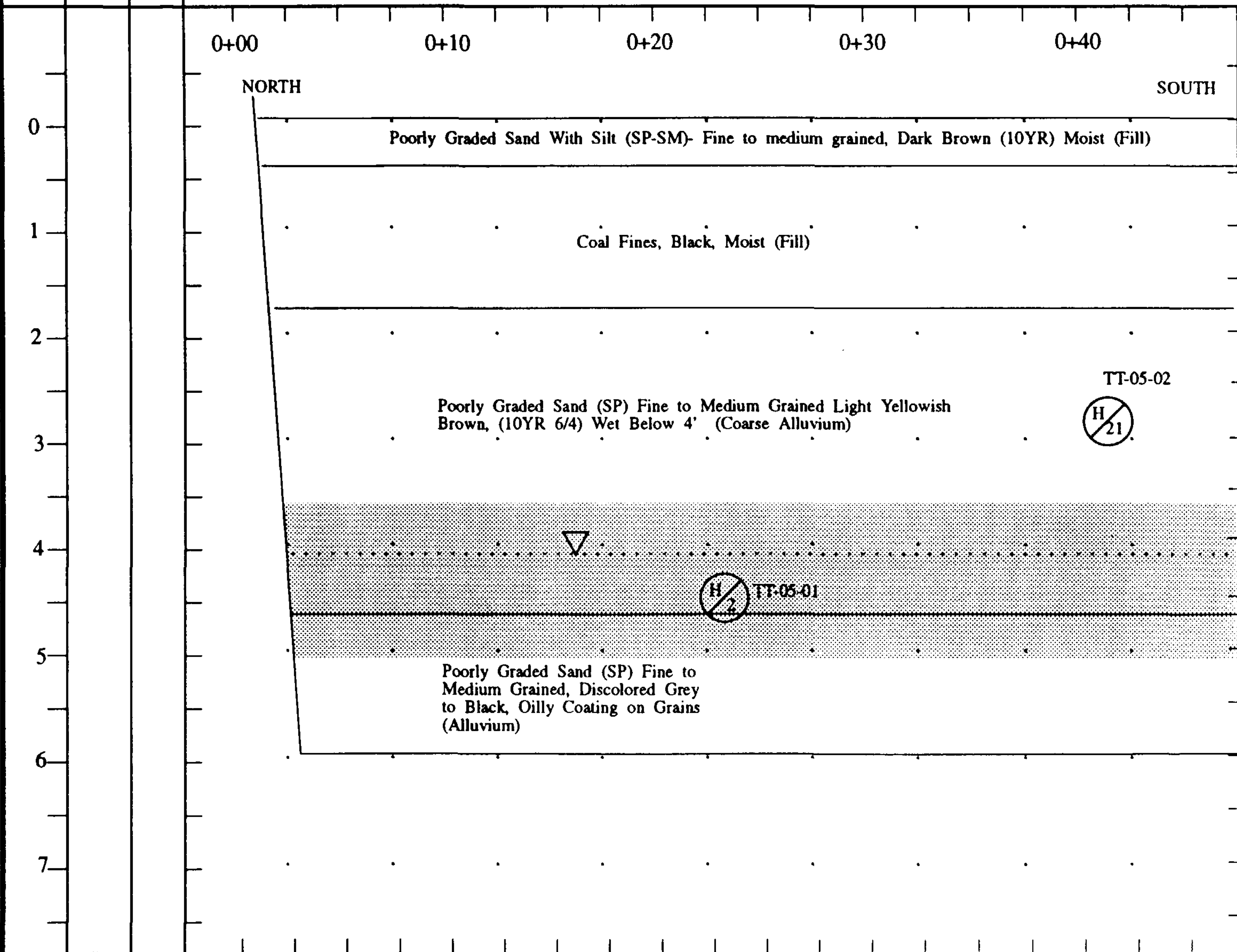
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF E WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/9/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 70' WIDTH 3-4' DEPTH 5-6' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Groundwater @ 4' W/Heavy Rainbow Sheen

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-05 SHEET 2 OF 2	TEST PIT WALL LOG

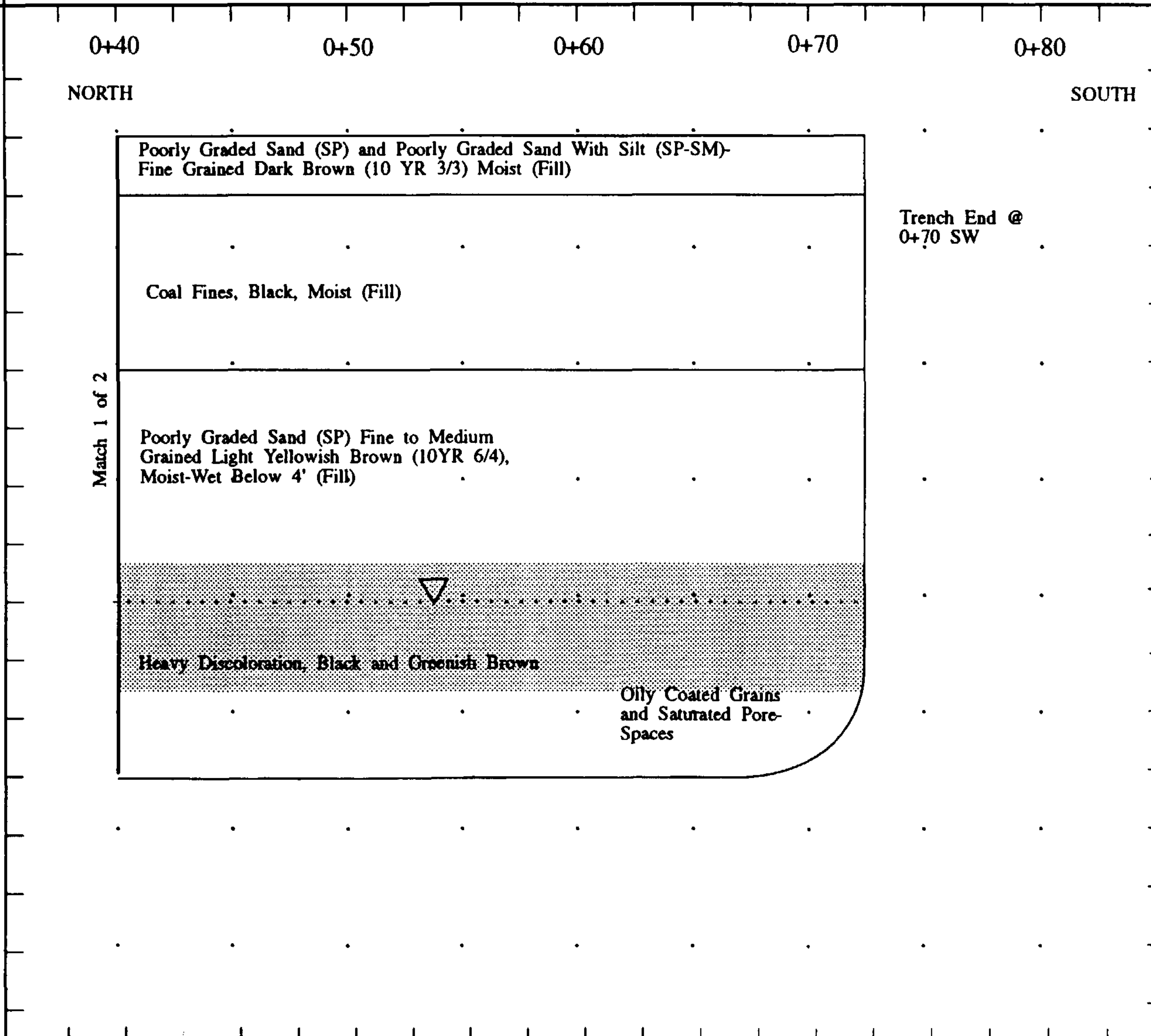
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF E WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/9/92-3/10/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 70' WIDTH 3-4' DEPTH 5-6' REMARKS ______

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE: TYPE AND NUMBER	SAMPLE: INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



COMMENTS

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

PROJECT NO.	TEST PIT NO.	
13/49-003JSL	TT-05E SHEET 1 OF 3	**TEST PIT WALL LOG**

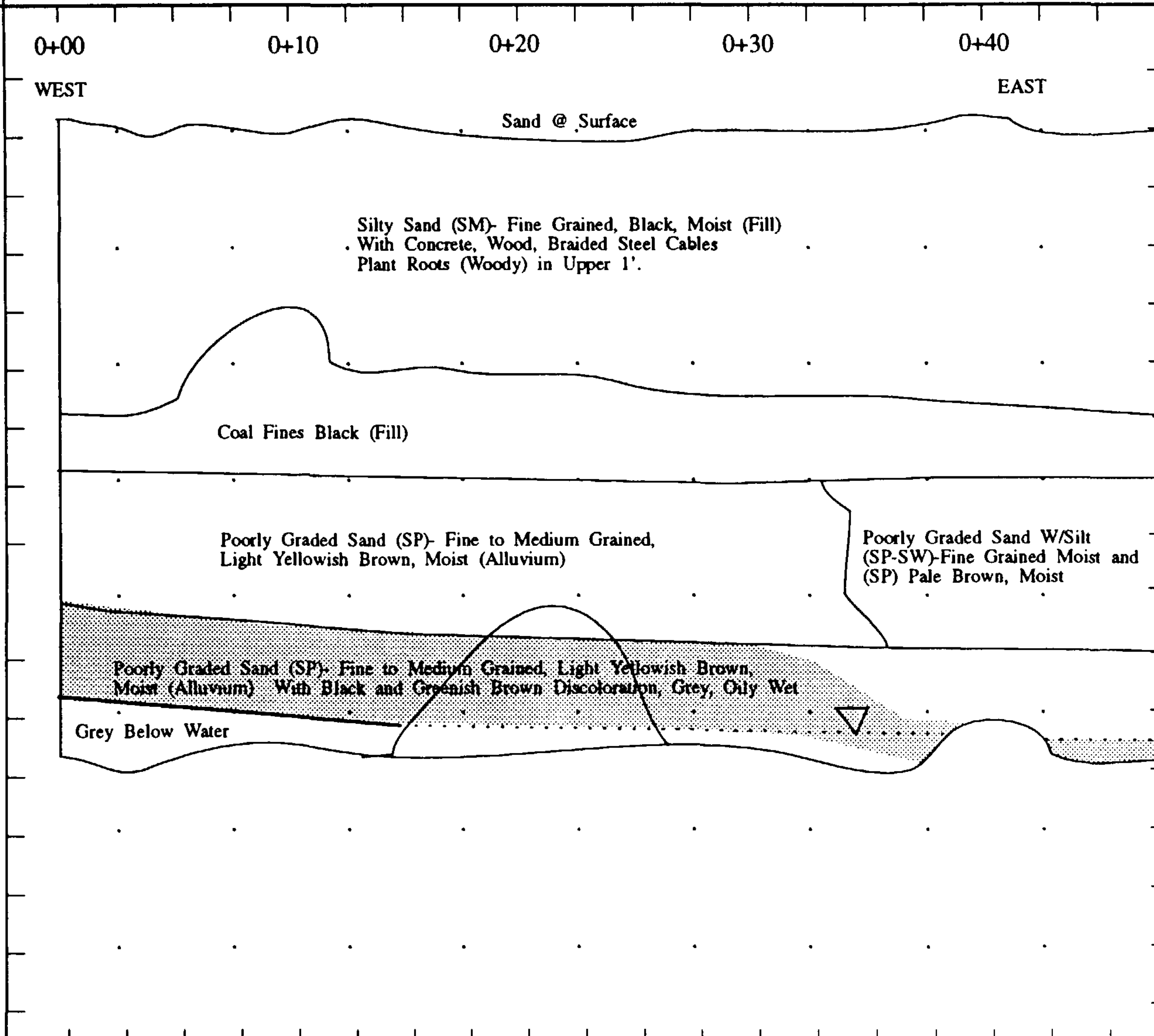
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF N WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/10/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 120 WIDTH 3-4' DEPTH 2 1/2-6' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



LENGTH

COMMENTS

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Rainbow Sheen On Groundwater

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-05E SHEET 2 OF 3

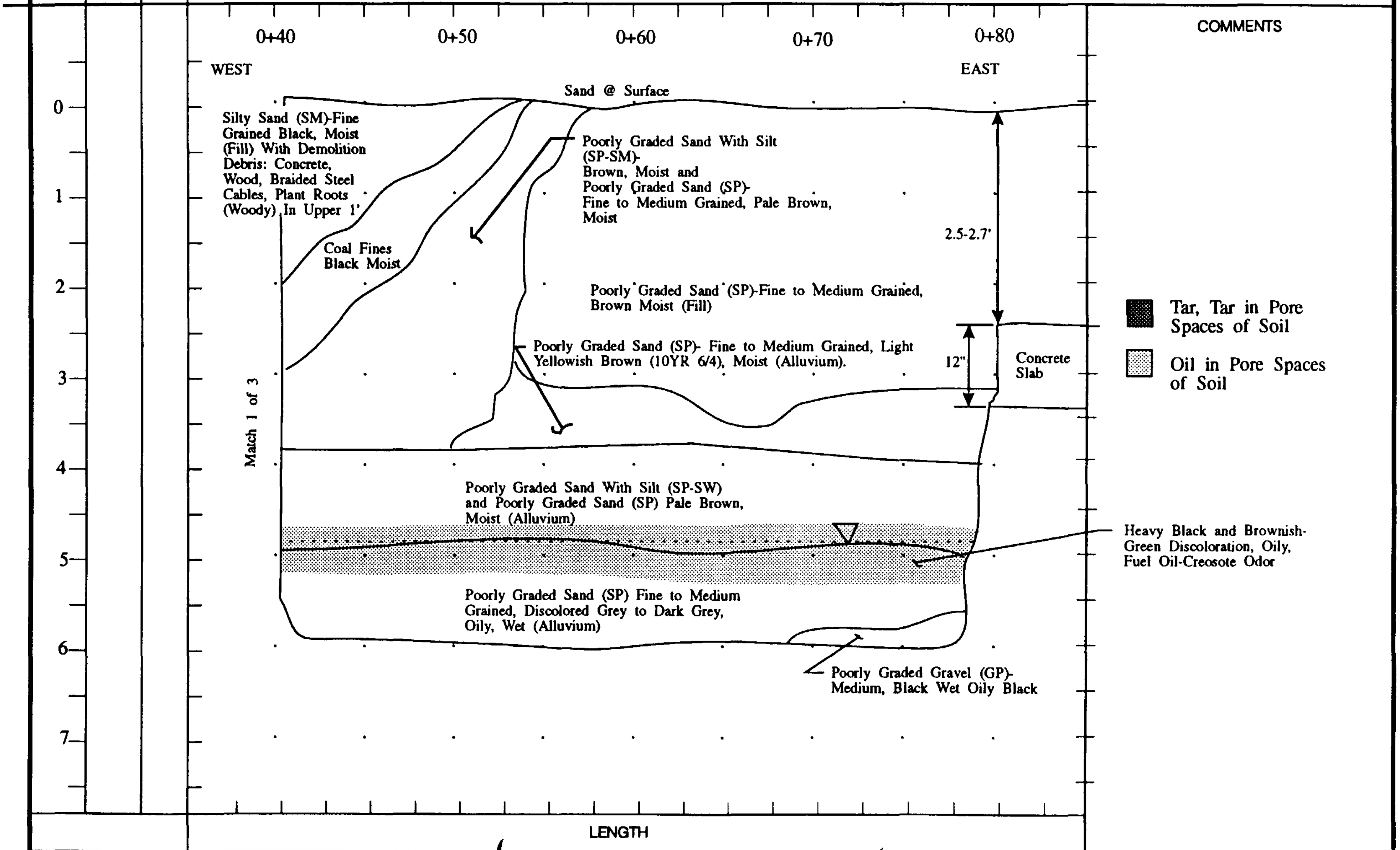
TEST PIT WALL LOG

PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF N WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/10/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 120 WIDTH 3-4' DEPTH 2 1/2-6' REMARKS ______



PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-05E SHEET 3 OF 3	TEST PIT WALL LOG

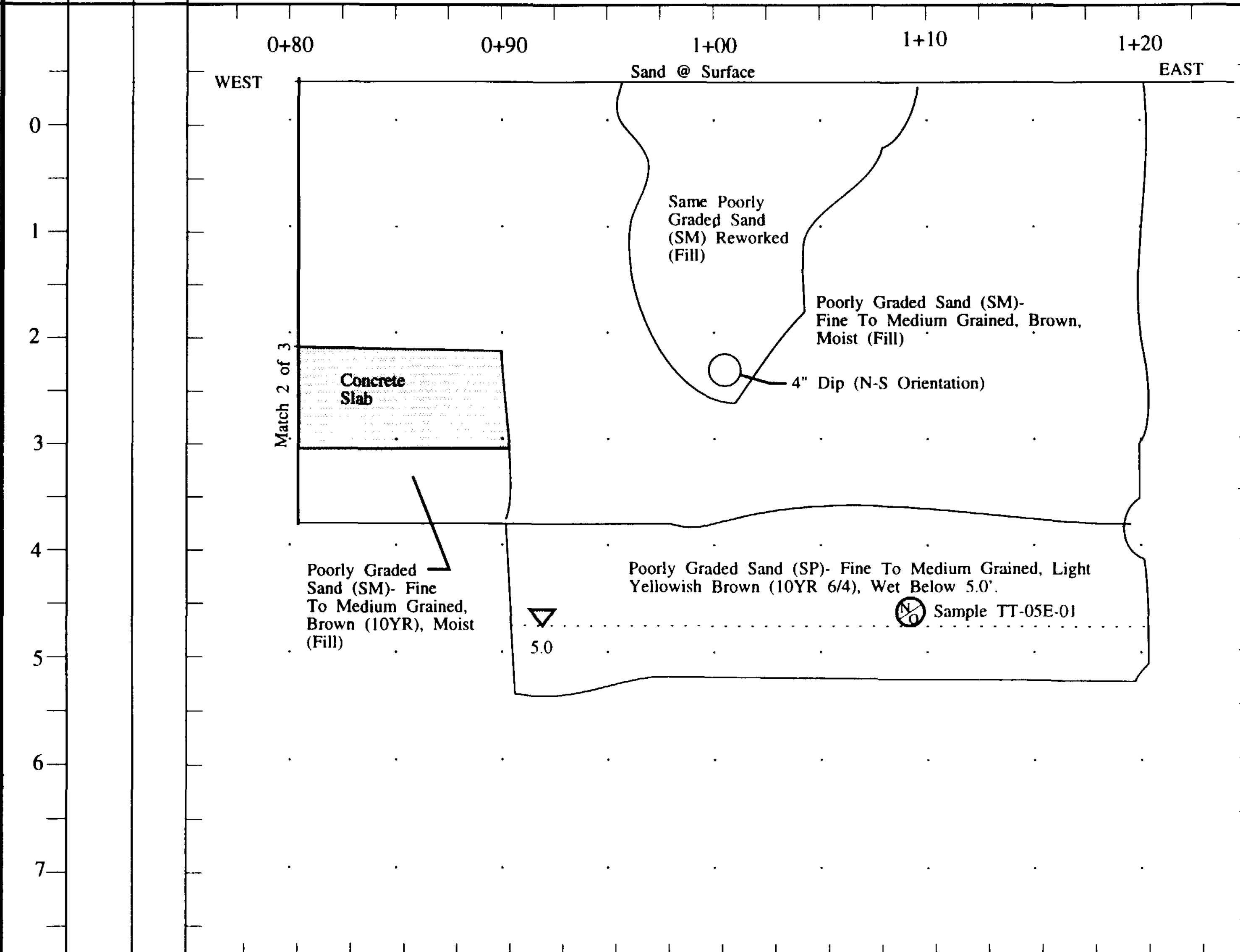
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF N WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/10/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 120 WIDTH 3-4' DEPTH 2 1/2-6' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER, INTERVAL



LENGTH

COMMENTS

End of Trench @1+20'E

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-06 SHEET 1 OF 2	**TEST PIT WALL LOG**

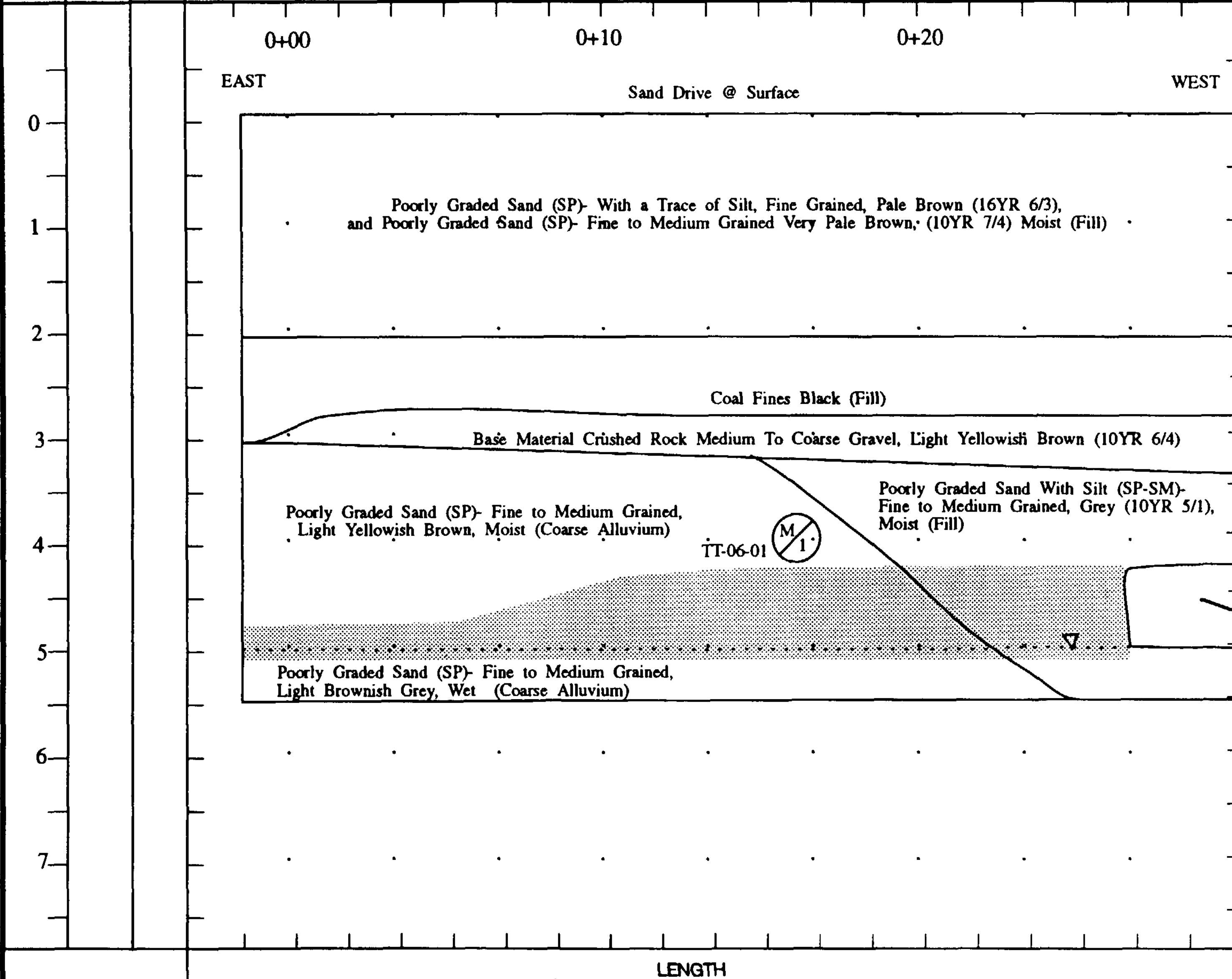
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF N WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/9/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 78' WIDTH 3-4' DEPTH 4.5-5.5' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER, INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Concrete Footing

Heavy Rainbow Sheen on Groundwater @ 0+10
Oily

PROJECT NO. 13/49-003JSL | TEST PIT NO. TT-06 | SHEET 2 OF 2

TEST PIT WALL LOG

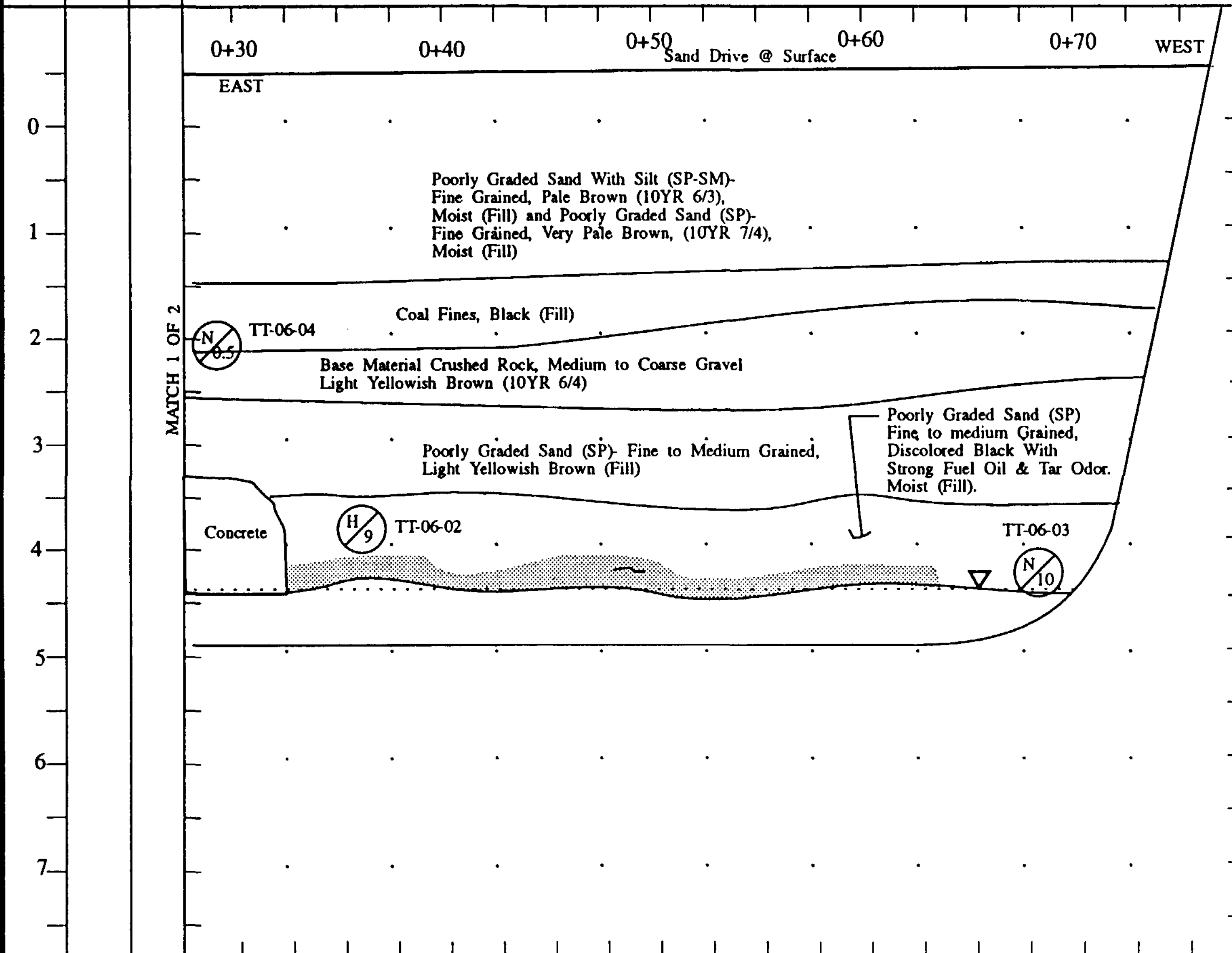
PROJECT: Northshore Gas Waukegan Coke Plant
LOCATION: Waukegan, IL.
MAP OF N WALL OF PIT

ELEVATION:
CONTRACTOR: Kirshoffer
DATE EXCAVATED: 3/9/92

WATER LEVEL AND DATE:
EXCAVATION METHOD: B-Hoe
LOGGER: JMF

APPROXIMATE DIMENSIONS: LENGTH 78' WIDTH 3-4' DEPTH 5 1/2'
REMARKS:

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER, INTERVAL



COMMENTS

End of Trench @ 0+78

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M 10

Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Rainbow Sheen on Groundwater

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-07 SHEET 1 OF 2	TEST PIT WALL LOG

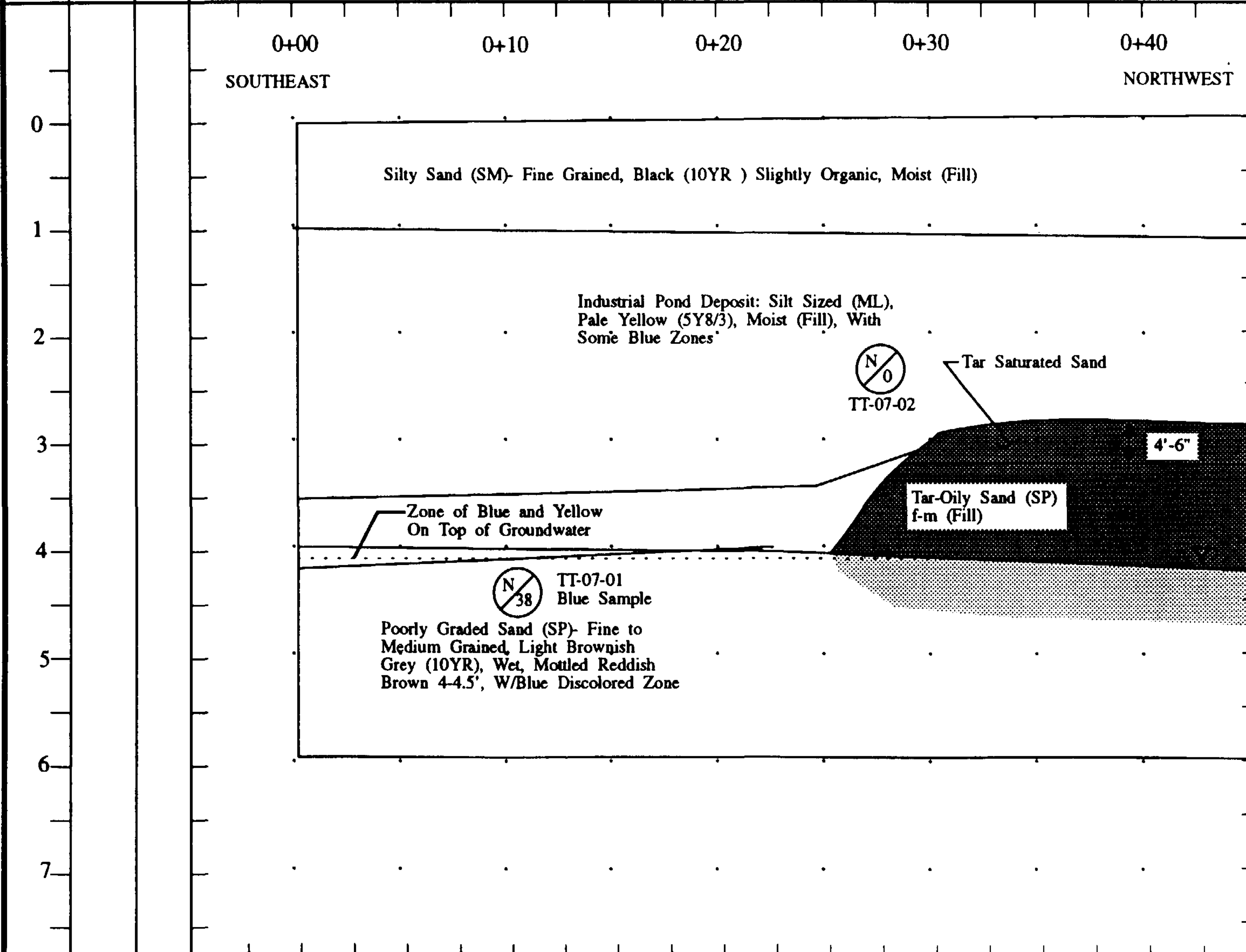
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NE WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/19/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 80' WIDTH 3-4' DEPTH 6' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



LENGTH

COMMENTS

Spoon Test Location and Result:

M/10 — Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy; Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Moderate Sheen in Groundwater 0+00 to 0+30
Heavy Sheen W/Oily Blebs, Golden Brown 0+31

TEST PIT WALL LOG

PROJECT NO.	TEST PIT NO.	SHEET	OF
13/49-003JSL	TT-07	2	2

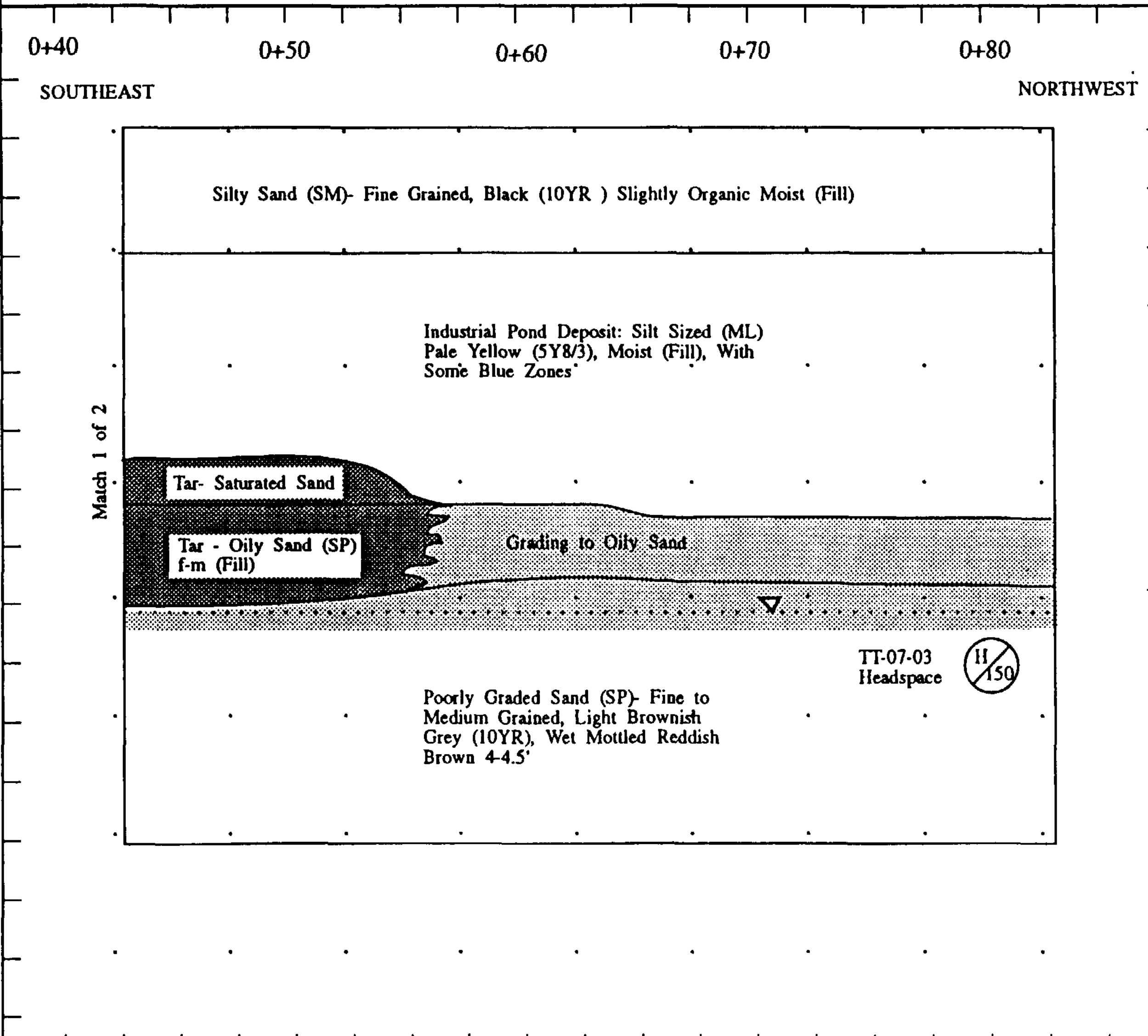
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NE WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/19/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 80' WIDTH 3-4' DEPTH 6' REMARKS ______

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE: TYPE AND NUMBER	SAMPLE: INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		

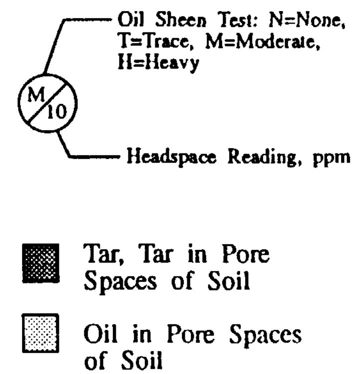


LENGTH

COMMENTS

End of Trench @ 0+80' NW

Spoon Test Location and Result:



PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-08 SHEET 1 OF 1	

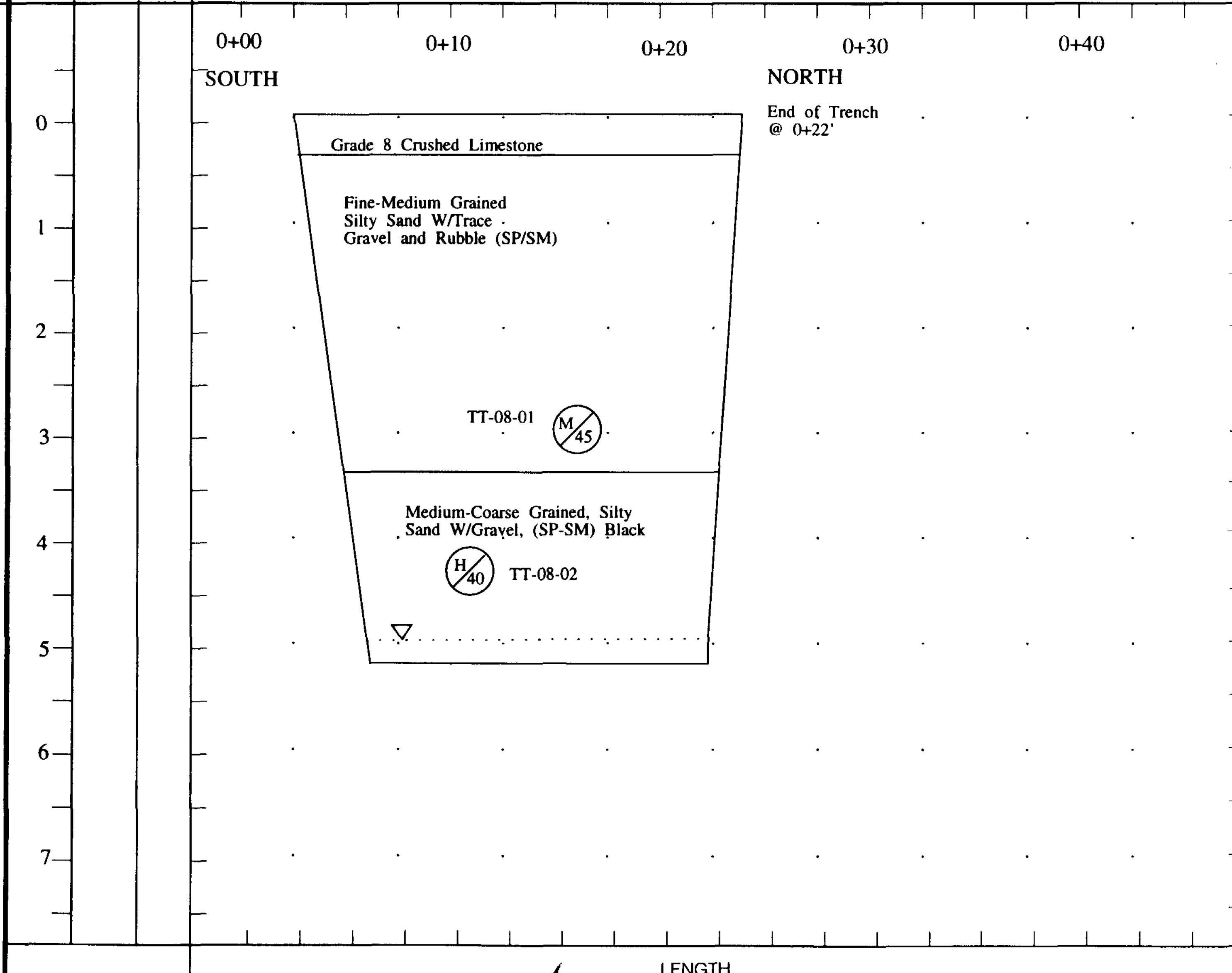
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF W WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/21/92

WATER LEVEL AND DATE 5' EXCAVATION METHOD B-Hoe LOGGER SEM

APPROXIMATE DIMENSIONS LENGTH 22' WIDTH 3-4' DEPTH 5.5' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M 10

Headspace Reading, ppm

Rubble Consists of Mostly Masonry Bricks, Large 3' x 4' of Sheet Metal, Wood

Heavy Sheen on Groundwater

PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-08A SHEET 1 OF 1	

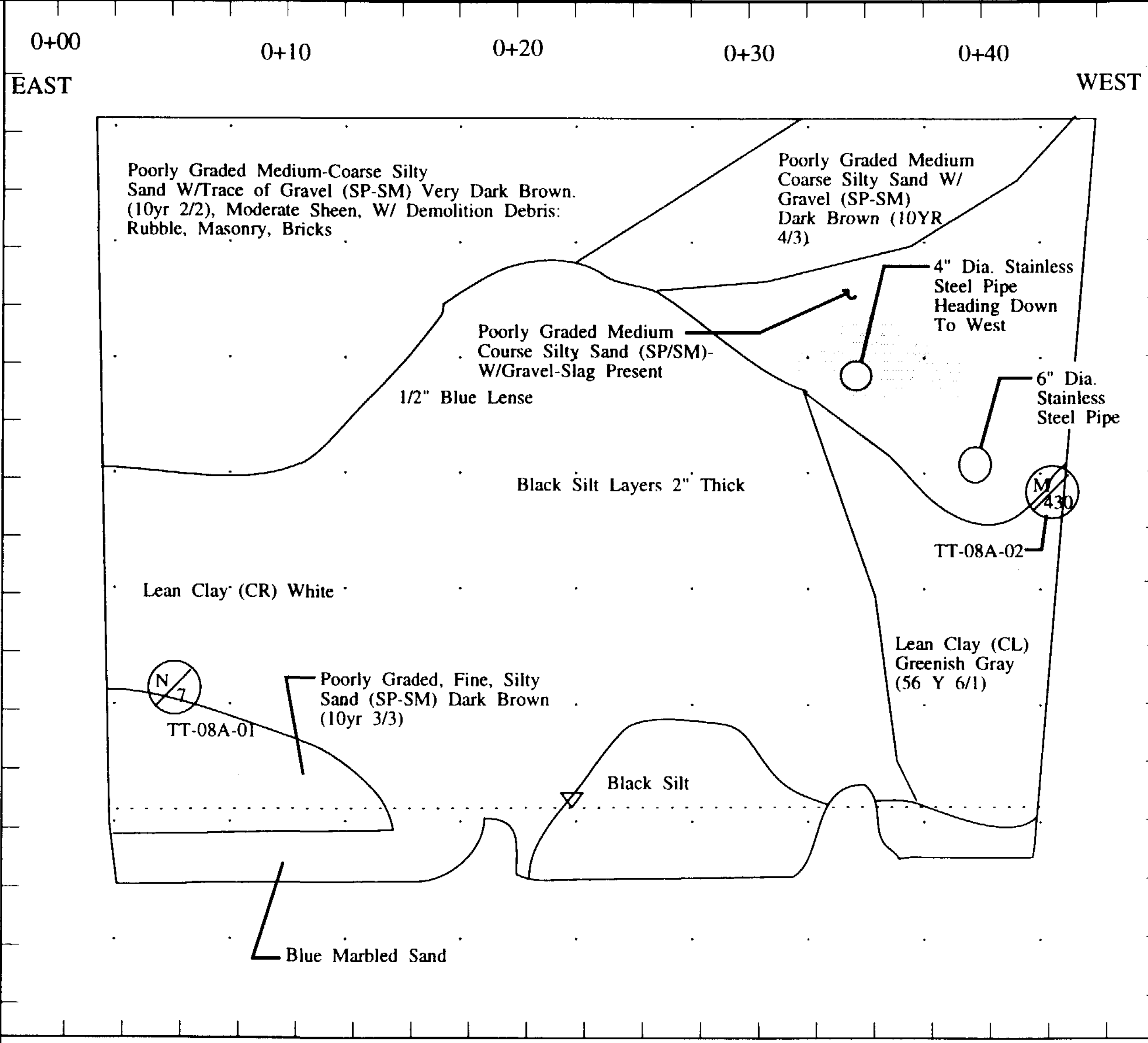
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/21/92

WATER LEVEL AND DATE 6' EXCAVATION METHOD B-Hoe LOGGER SEM

APPROXIMATE DIMENSIONS LENGTH 45' WIDTH 3-4' DEPTH 6.5' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



LENGTH

COMMENTS

Spoon Test Location and Result:

M/10 — Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy; Headspace Reading, ppm

Between Sta. 0+00 and 0+30 Trench Emitted a "Musty" Odor.

A Heavy Gasoline Smell Near Sta. 0+20 & 0+40

Sulfur Odor Present In Sand, Depth 5-6', Sta. 0+00 to 0+05

End of Trench @ 0+45'

Heavy Oil Sheen on Groundwater

■ Tar, Tar in Pore Spaces of Soil

□ Oil in Pore Spaces of Soil

TEST PIT WALL LOG

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-09	SHEET 1 OF 2

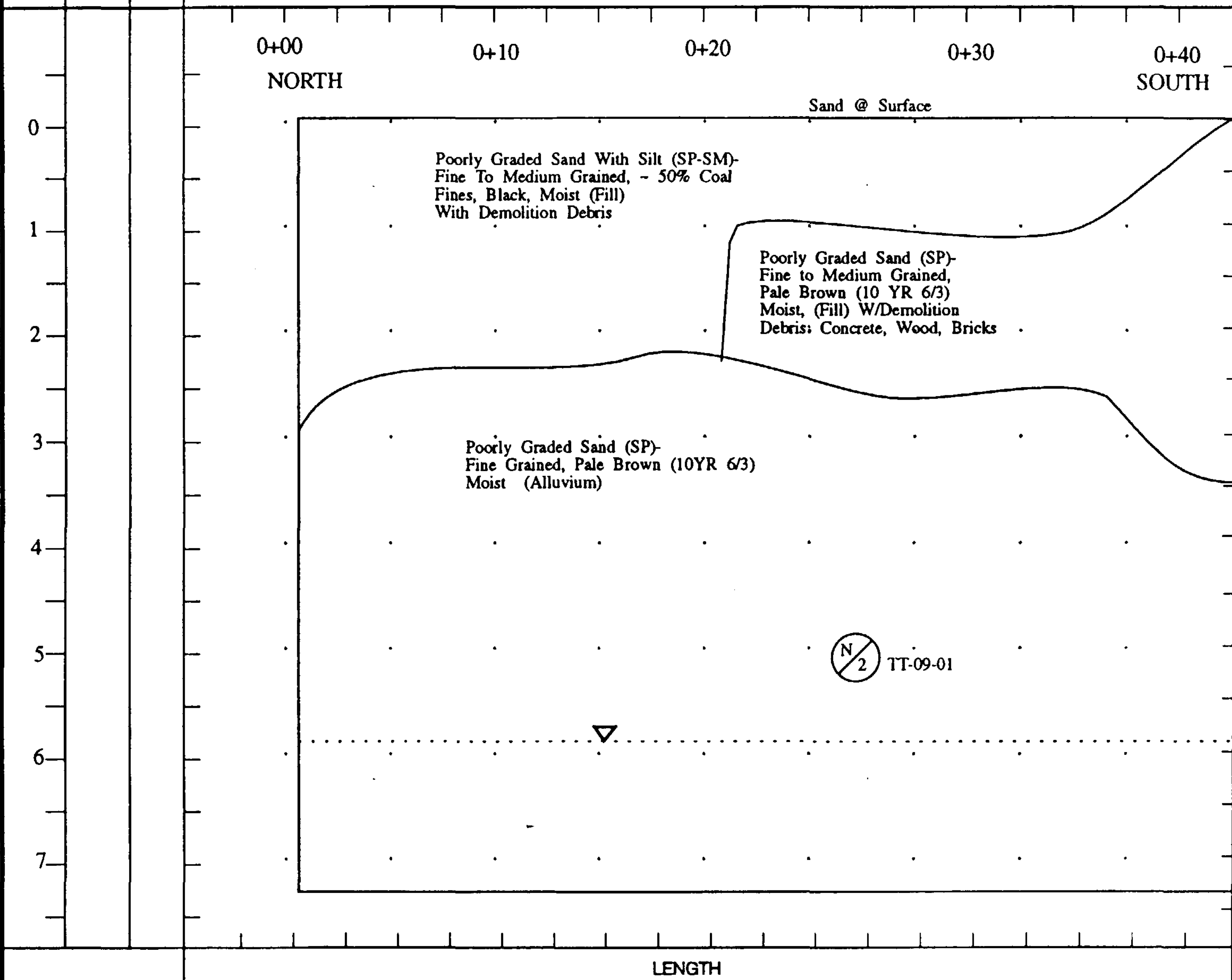
PROJECT Northshore Gas Waukegan Coke Plant — LOCATION Waukegan, IL. — MAP OF E WALL OF PIT

ELEVATION ________ — CONTRACTOR Kirshoffer — DATE EXCAVATED 3/11/92

WATER LEVEL AND DATE ________ — EXCAVATION METHOD B-Hoe — LOGGER SEM

APPROXIMATE DIMENSIONS — LENGTH 70' — WIDTH 3-4' — DEPTH 5-7' — REMARKS ________

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location
and Result:

Oil Sheen Test: N=None,
T=Trace, M=Moderate,
H=Heavy

M/10

Headspace Reading, ppm

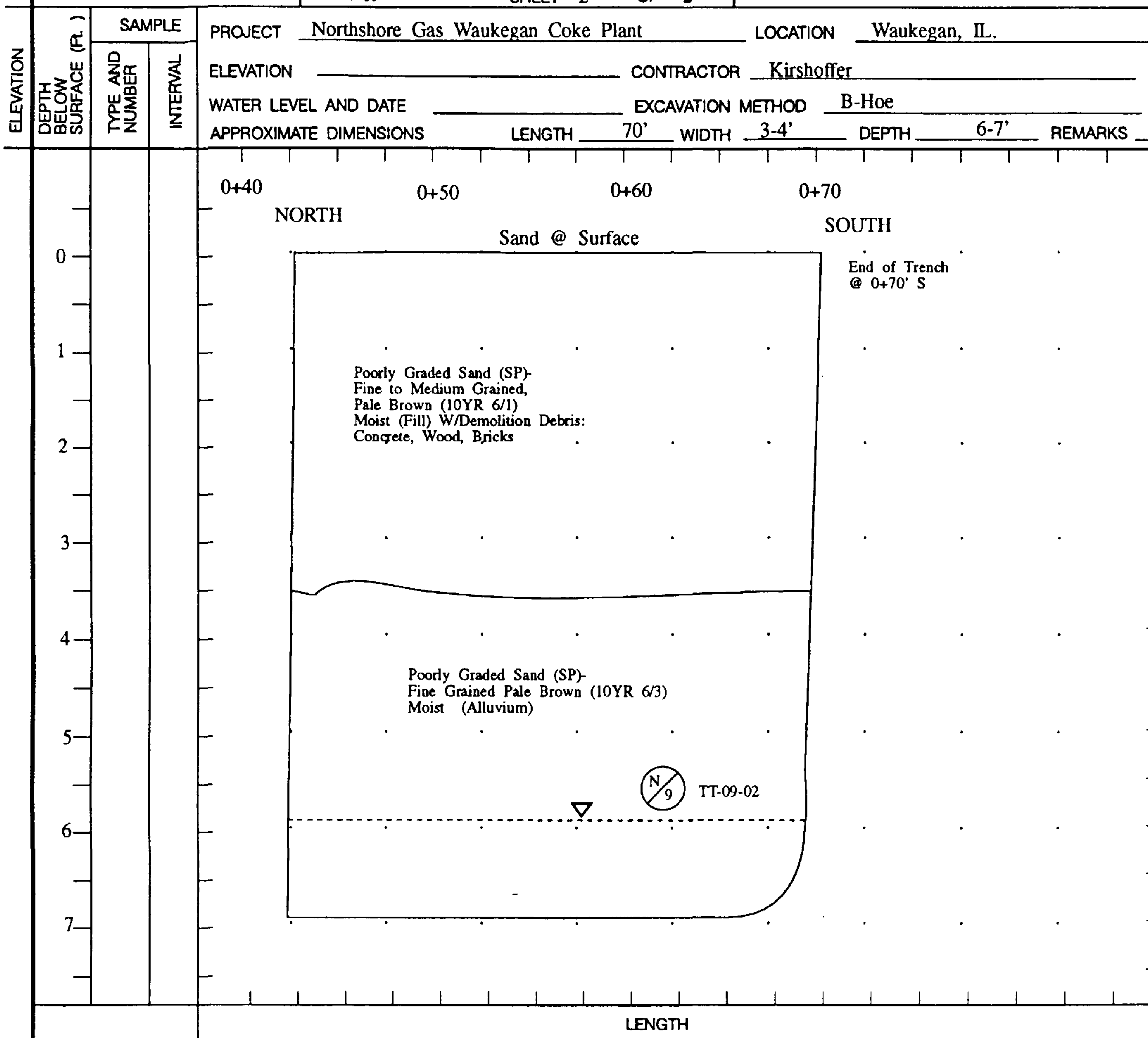
PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-09 SHEET 2 OF 2	TEST PIT WALL LOG

PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF E WALL OF PIT

ELEVATION ________ CONTRACTOR Kirshoffer DATE EXCAVATED 3/11/92

WATER LEVEL AND DATE ________ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 70' WIDTH 3-4' DEPTH 6-7' REMARKS ________



COMMENTS

Spoon Test Location and Result:

M/10

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

Headspace Reading, ppm

Slight to Moderate Sheen on Groundwater 0+40 to End of Trench

TEST PIT WALL LOG

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-10 SHEET 1 OF 1

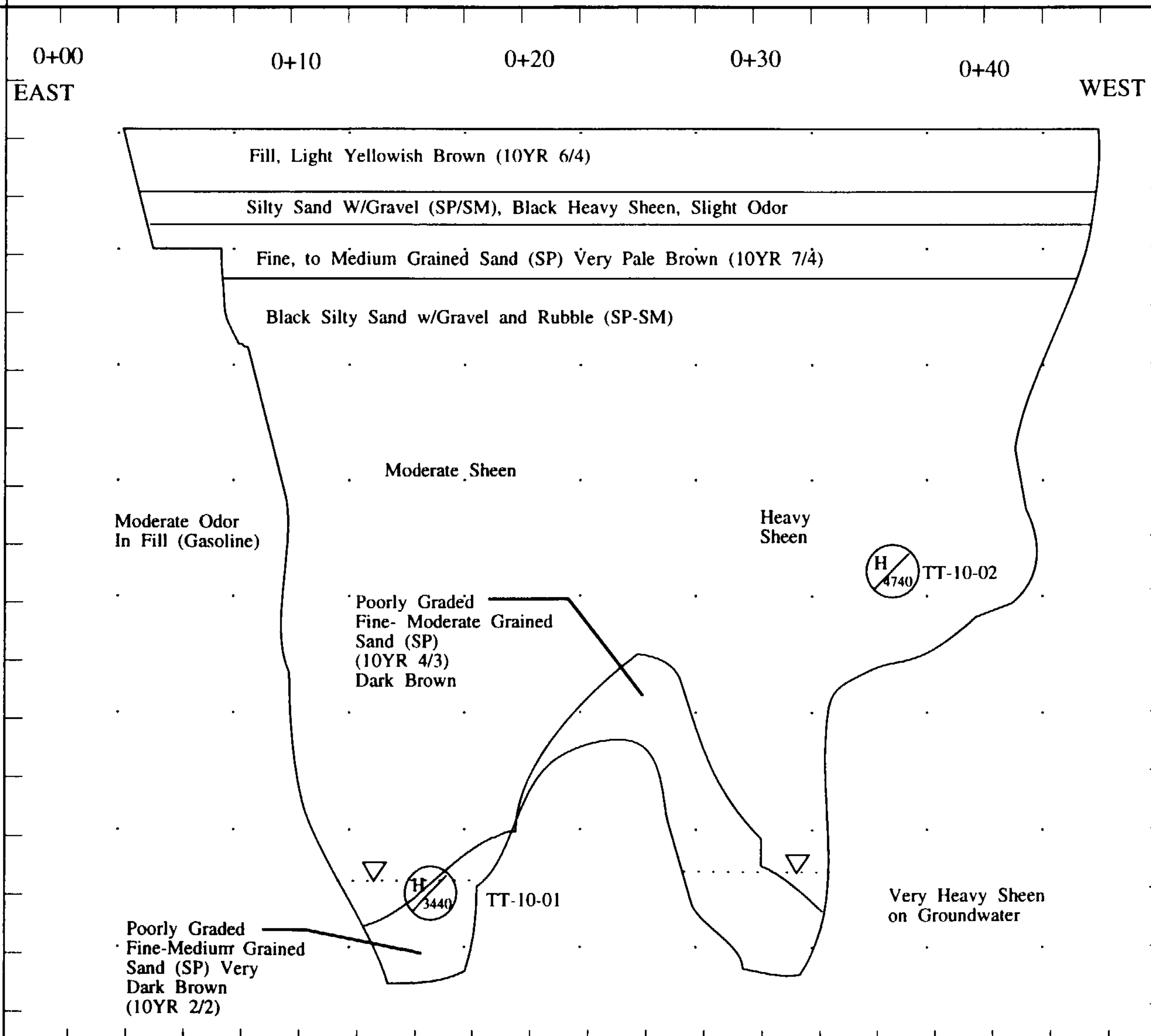
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/21/92

WATER LEVEL AND DATE 6-1/2' EXCAVATION METHOD B-Hoe LOGGER SEM

APPROXIMATE DIMENSIONS LENGTH 45' WIDTH 4-5' DEPTH 5-7' REMARKS ______

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE: TYPE AND NUMBER	SAMPLE: INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



LENGTH

COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Trench is Full of Demolition Debris of Masonry Bricks, Large Dia. (72") Concrete chunks, pipes (Not Connected to Any-thing, Varying Dia.) Wire, Wood, Concrete Chunks <2' Dia., Rubble Varies Up 40-50% of Fill.

End of Trench @ 0+ 45'

TEST PIT WALL LOG

PROJECT NO.	TEST PIT NO.	SHEET	OF
13/49-003JSL	TT-11	1	1

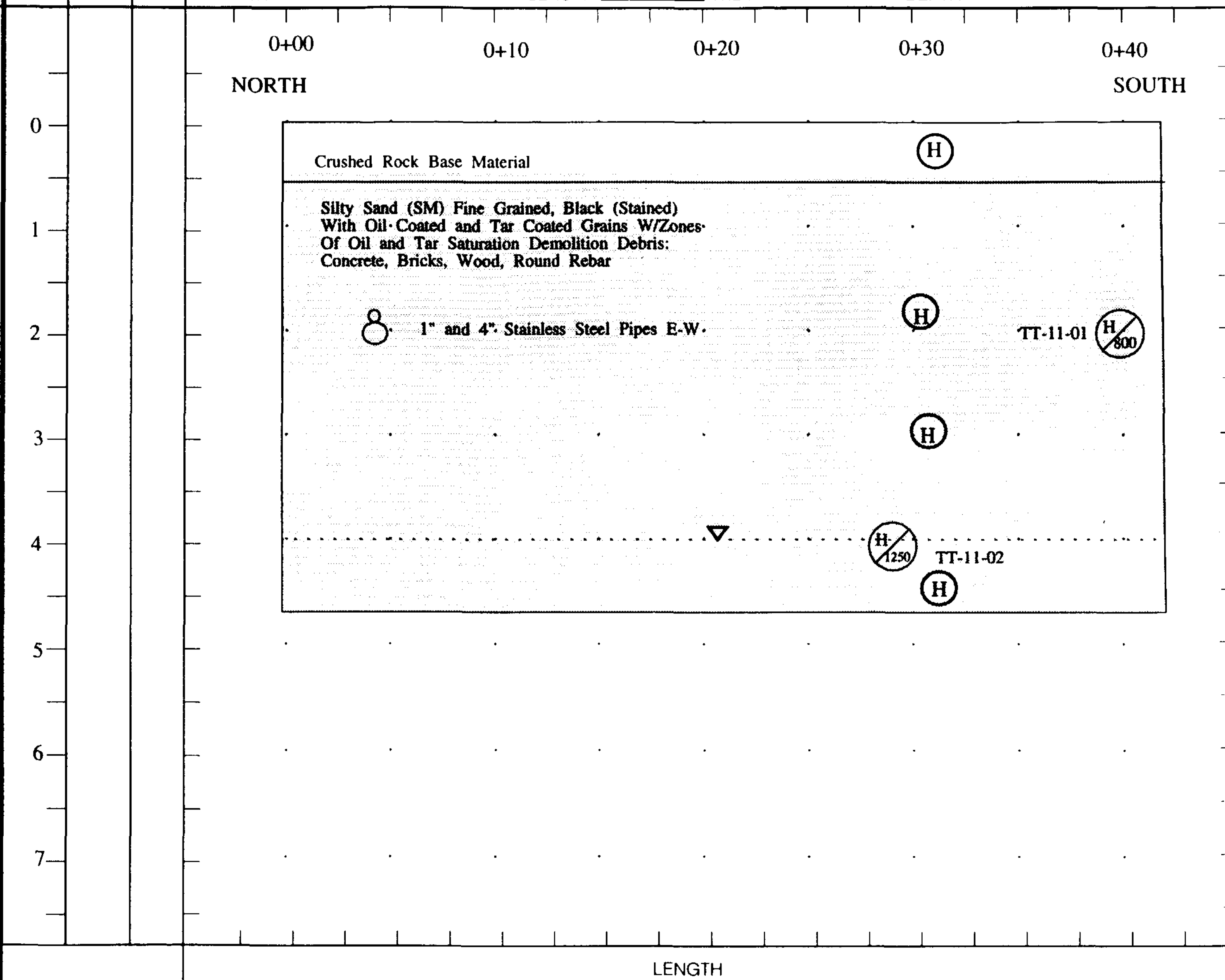
PROJECT: Northshore Gas Waukegan Coke Plant
LOCATION: Waukegan, IL.
MAP OF: E WALL OF PIT

ELEVATION:
CONTRACTOR: Kirshoffer
DATE EXCAVATED: 3/18/92

WATER LEVEL AND DATE:
EXCAVATION METHOD: B-Hoe
LOGGER: JMF

APPROXIMATE DIMENSIONS: LENGTH 41' WIDTH 3-4" DEPTH 4.5'
REMARKS:

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Spoon Test Location and Result:

- N None
- T Trace
- M Moderate
- H Heavy

Groundwater @ 4' With Heavy Oily Film, Heavy Sheen

■ Tar, Tar in Pore Spaces of Soil

□ Oil in Pore Spaces of Soil

TEST PIT WALL LOG

PROJECT NO.	TEST PIT NO.	SHEET	OF
13/49-003JSL	TT-12	1	1

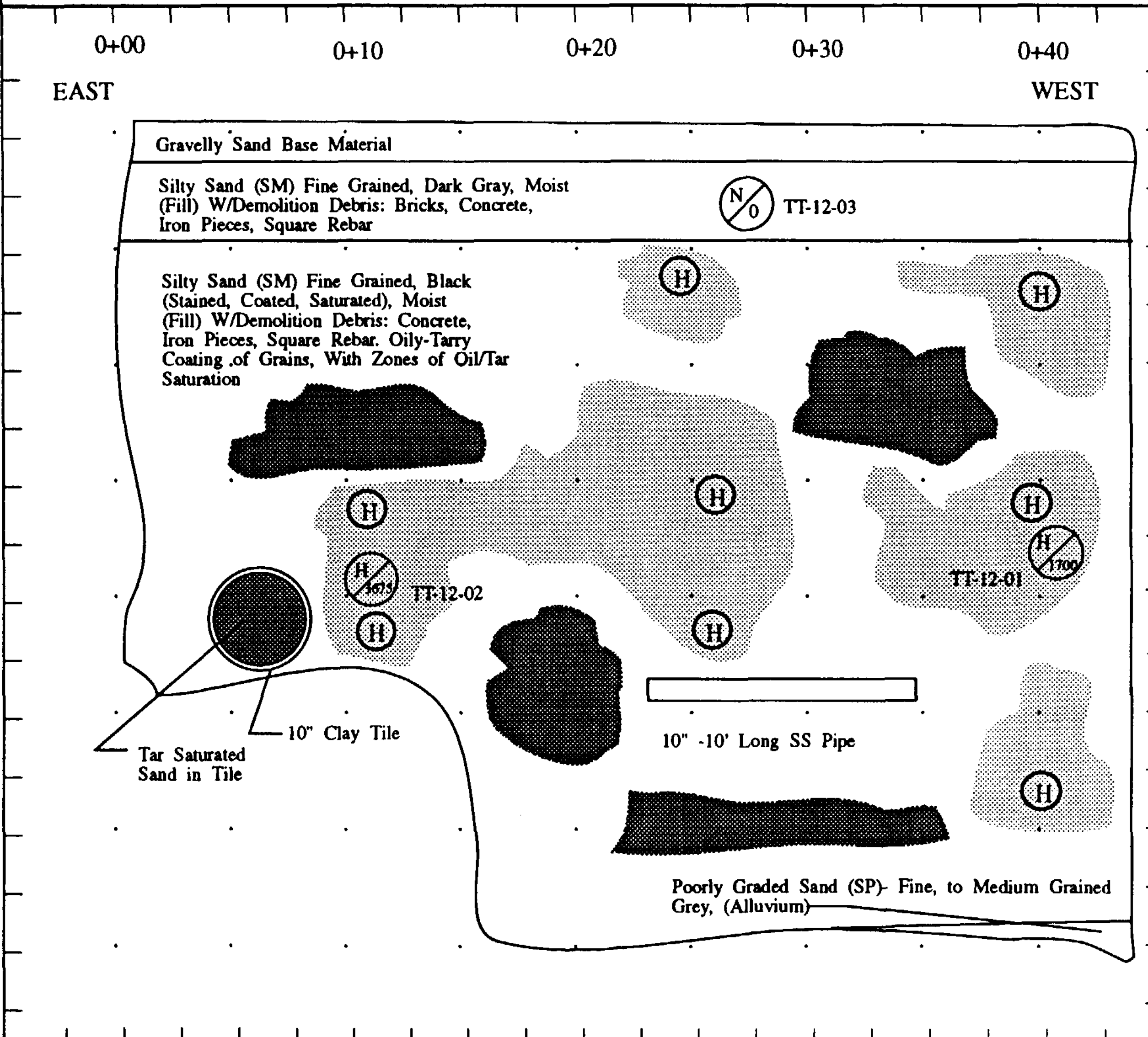
PROJECT: Northshore Gas Waukegan Coke Plant LOCATION: Waukegan, IL. MAP OF: S WALL OF PIT

ELEVATION: ______ CONTRACTOR: Kirshoffer DATE EXCAVATED: 3/18/92

WATER LEVEL AND DATE: ______ EXCAVATION METHOD: B-Hoe LOGGER: JMF

APPROXIMATE DIMENSIONS LENGTH: 42' WIDTH: 3-4" DEPTH: 5-6' REMARKS: ______

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE: TYPE AND NUMBER	SAMPLE: INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



LENGTH

COMMENTS

Spoon Test Location and Result:

M/10 — Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy; Headspace Reading, ppm

Spoon Test Location and Result:

- (N) None
- (T) Trace
- (M) Moderate
- (H) Heavy

Very Heavy Sheen on Groundwater With Thick Black Oily Blebs

No Static Groundwater Level Recorded-Rising When Backfilled-Slow Recovery Due to Oil/Tar Saturated Soils.

- Tar, Tar in Pore Spaces of Soil
- Oil in Pore Spaces of Soil

TEST PIT WALL LOG

PROJECT NO.	TEST PIT NO.	SHEET	OF
13/49-003JSL	TT-13	1	1

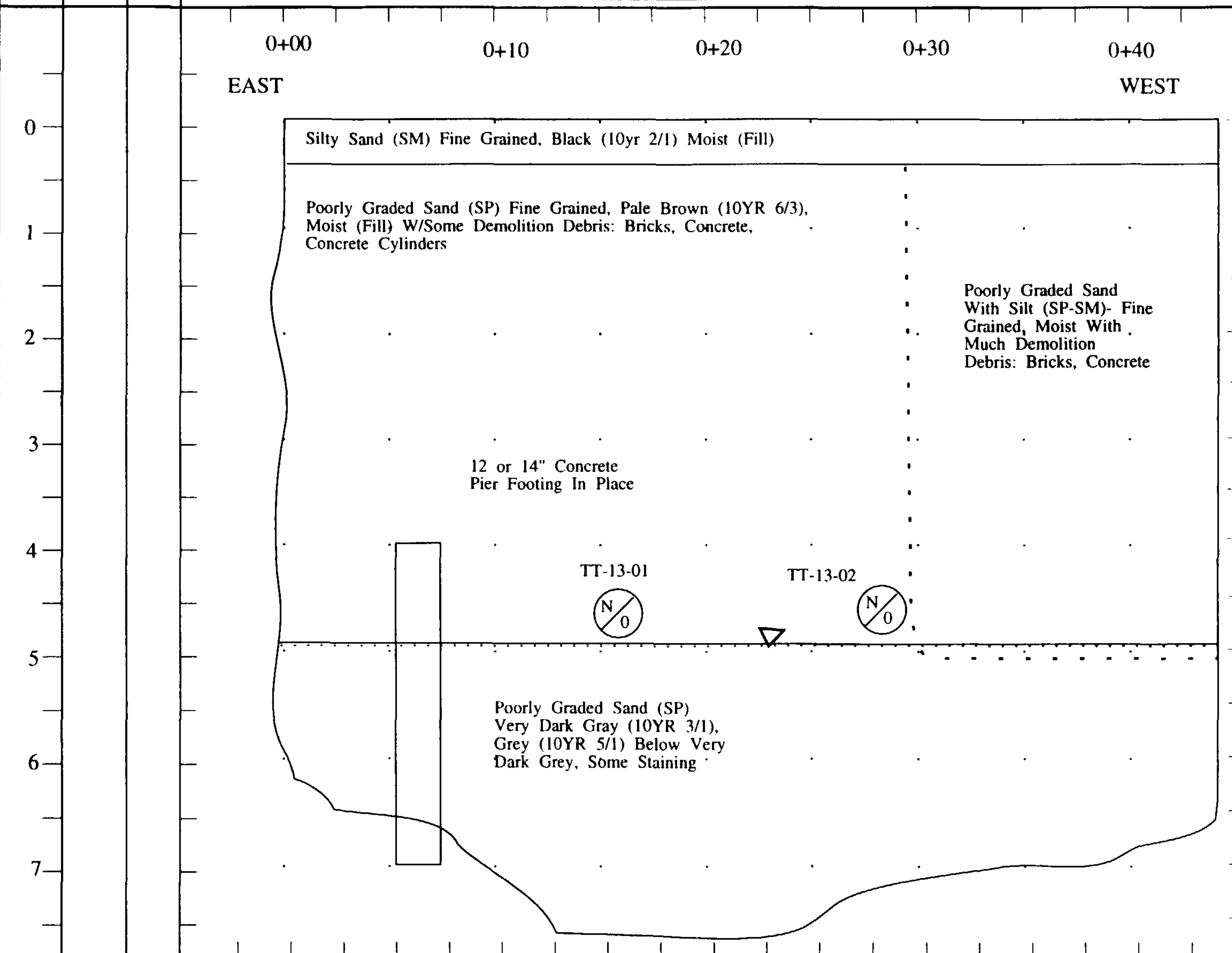
PROJECT: Northshore Gas Waukegan Coke Plant
LOCATION: Waukegan, IL.
MAP OF: S WALL OF PIT

ELEVATION:
CONTRACTOR: Kirshoffer
DATE EXCAVATED: 3/16/92

WATER LEVEL AND DATE:
EXCAVATION METHOD: B-Hoe
LOGGER: JMF

APPROXIMATE DIMENSIONS: LENGTH 50' WIDTH 3-4" DEPTH 7.5'
REMARKS:

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER, INTERVAL



LENGTH

COMMENTS

Spoon Test Location and Result:

M/10 — Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy; Headspace Reading, ppm

End of Trench @ 0+50 W

TEST PIT WALL LOG

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-14 SHEET 1 OF 2

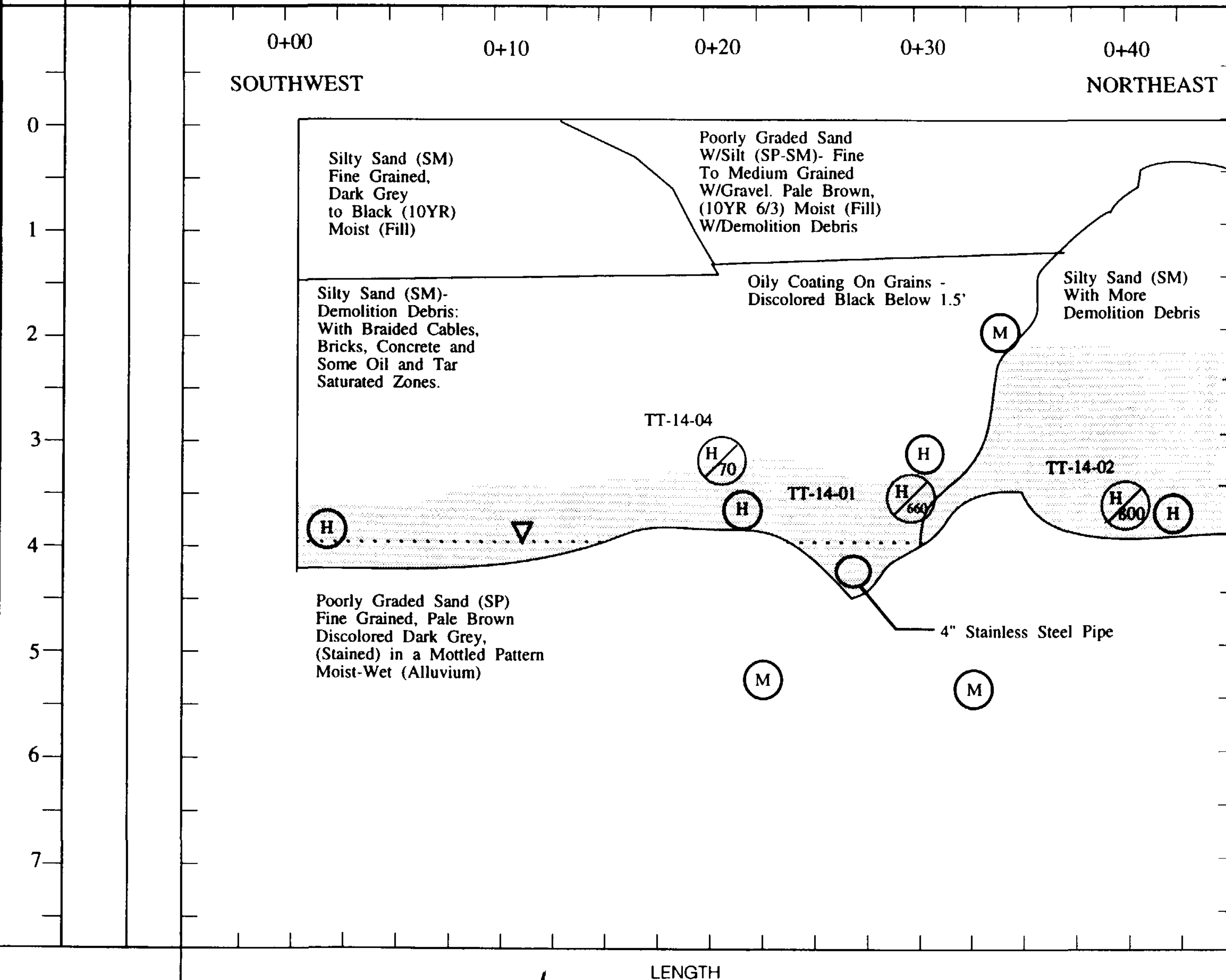
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NW WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/16/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 70' WIDTH 3-4" DEPTH 7.5' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Spoon Test Location and Result:

- (N) None
- (T) Trace
- (M) Moderate
- (H) Heavy

Shaded Zone Contains Oil Coated Grains, With Some Saturated Areas. Heavy Sheen and Oily Blebs on Groundwater Surface.

■ Tar, Tar in Pore Spaces of Soil

□ Oil in Pore Spaces of Soil

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-14 SHEET 2 OF 2	TEST PIT WALL LOG

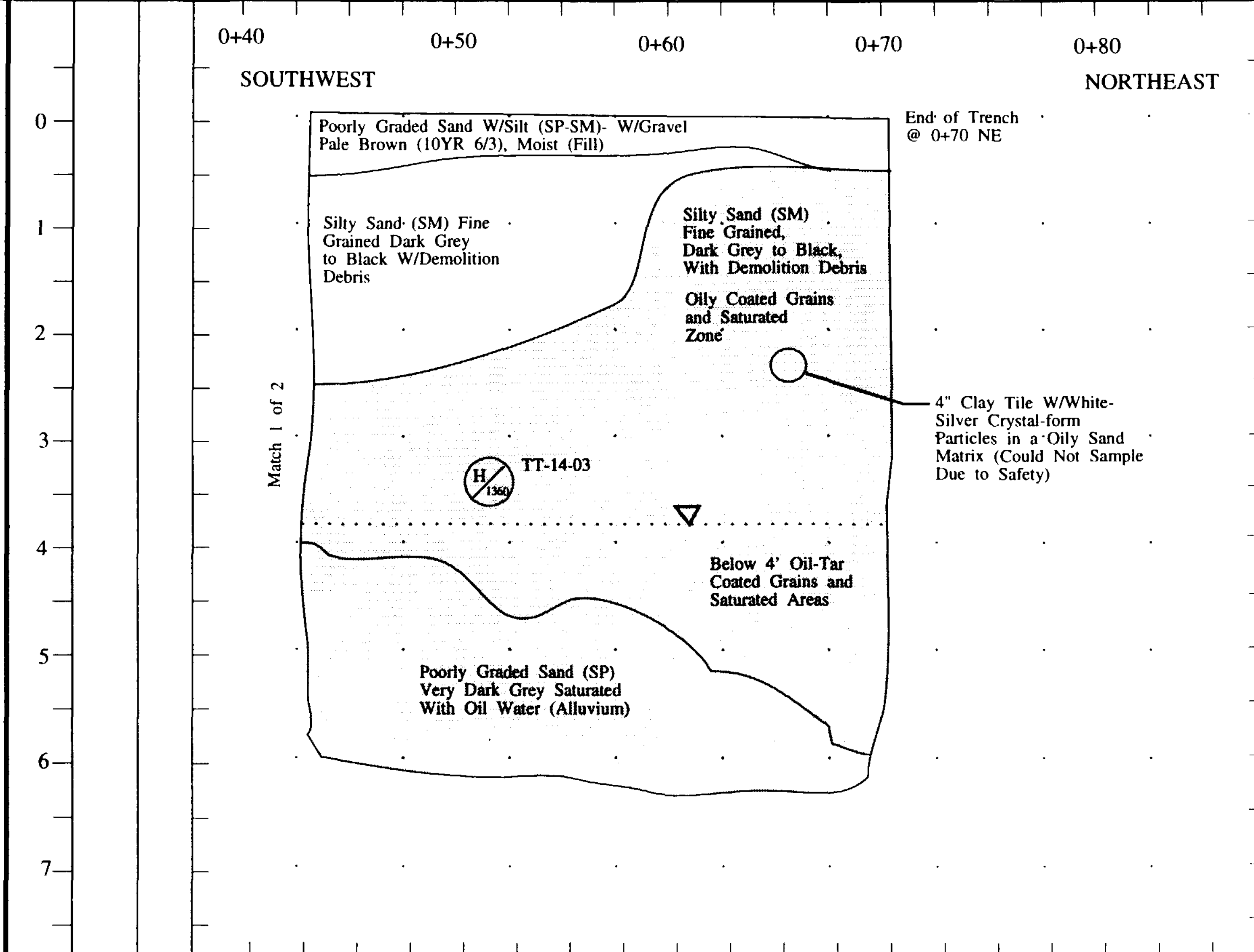
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF NW WALL OF PIT

ELEVATION CONTRACTOR Kirshoffer DATE EXCAVATED 3/18/92

WATER LEVEL AND DATE EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 70' WIDTH 3-4" DEPTH 6' REMARKS

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



LENGTH

COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M 10

Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

TEST PIT WALL LOG

PROJECT NO.	TEST PIT NO.	
13/49-003JSL	TT-15 SHEET 1 OF 3	

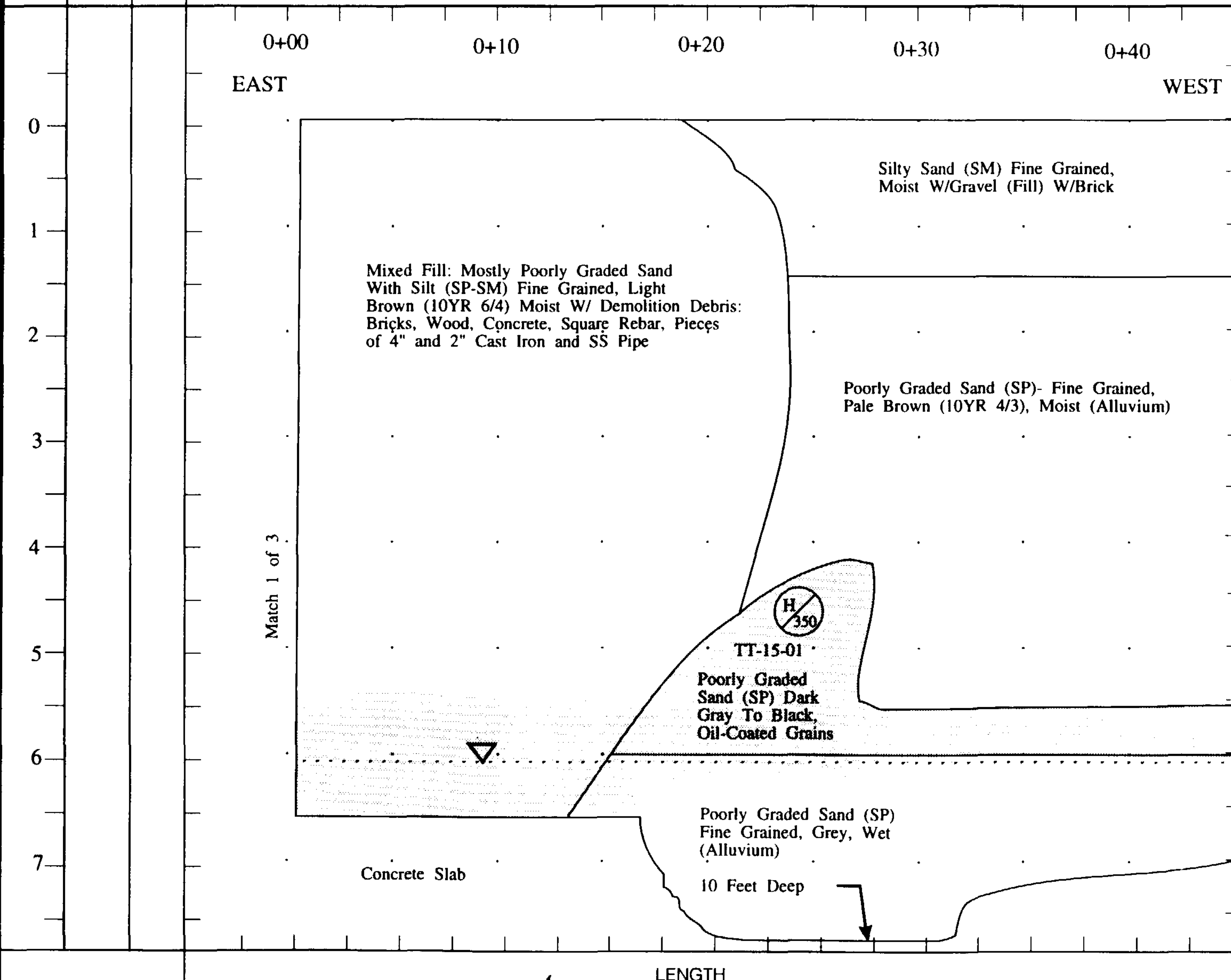
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/17/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 125' WIDTH 3-4' DEPTH 5 - 10' REMARKS ______

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE TYPE AND NUMBER	SAMPLE INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M 10

Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Sheen on Groundwater

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-15 SHEET 2 OF 3

TEST PIT WALL LOG

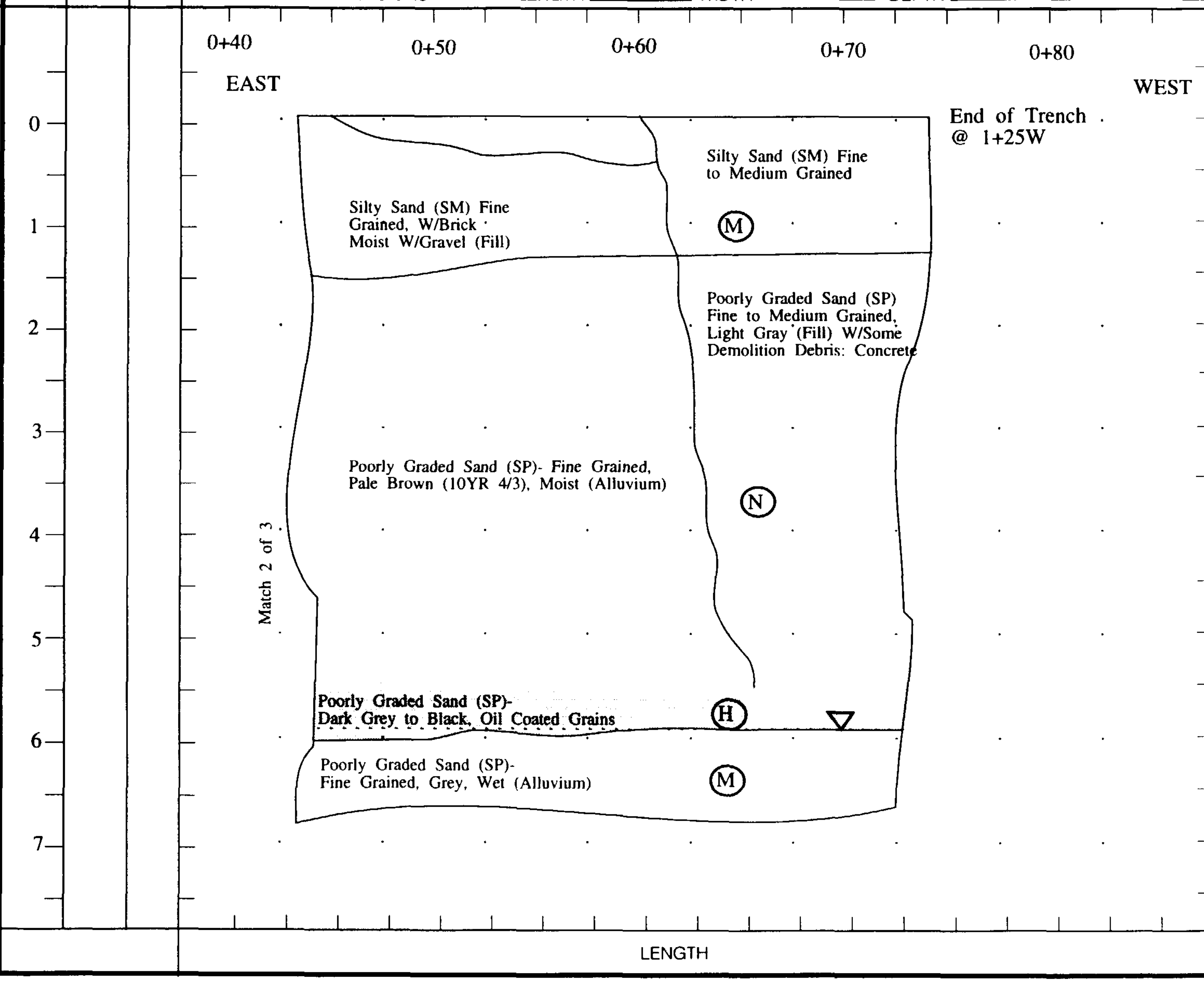
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/17/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 125' WIDTH 3-4' DEPTH 5-10' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

- N None
- T Trace
- M Moderate
- H Heavy

■ Tar, Tar in Pore Spaces of Soil

□ Oil in Pore Spaces of Soil

Heavy Sheen on Groundwater

TEST PIT WALL LOG

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-15 EXT SHEET 3 OF 3

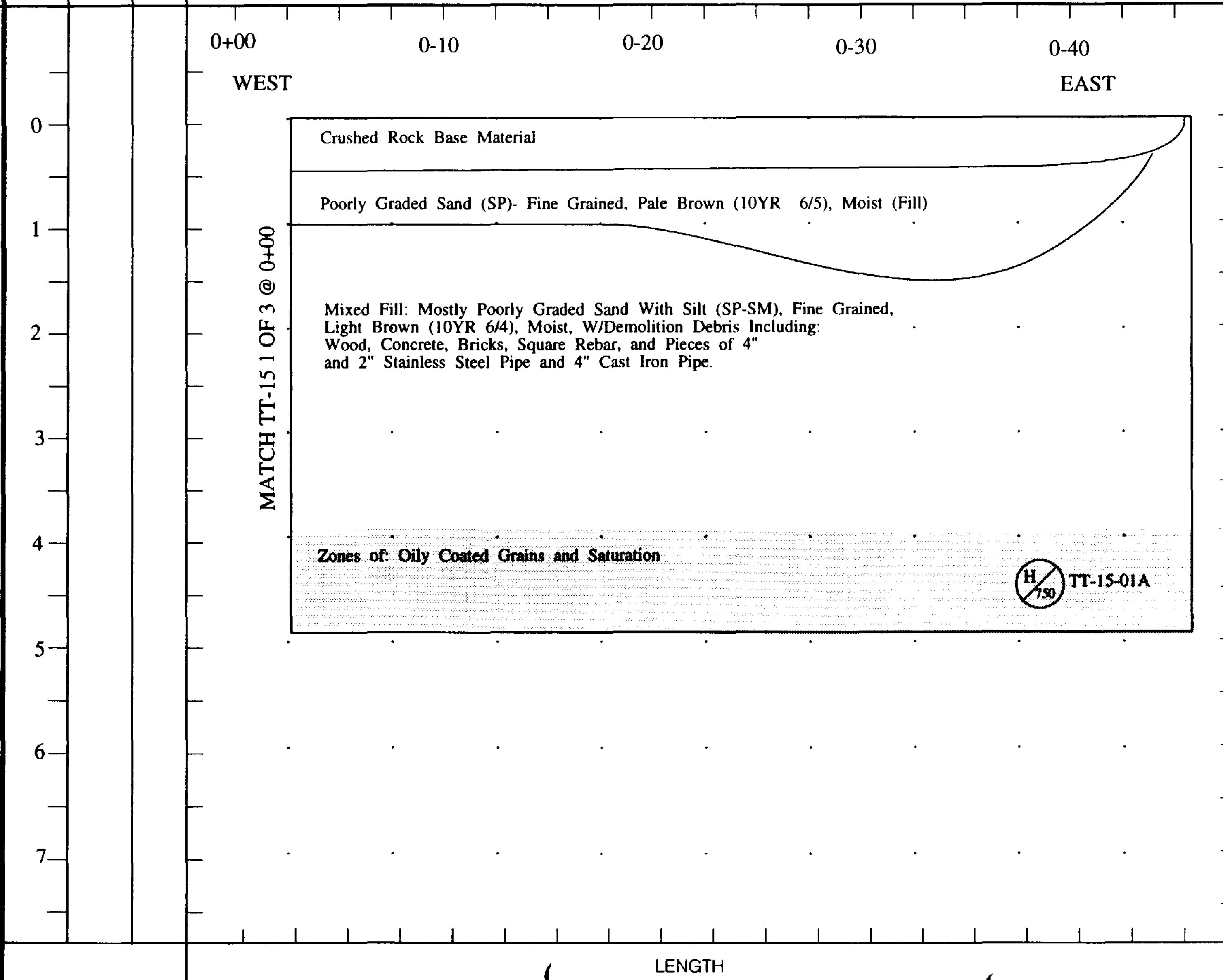
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/18/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 125' WIDTH 3-4" DEPTH 5 - 10' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

M/10 — Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy; Headspace Reading, ppm

■ Tar, Tar in Pore Spaces of Soil

□ Oil in Pore Spaces of Soil

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-16 SHEET 1 OF 1	**TEST PIT WALL LOG**

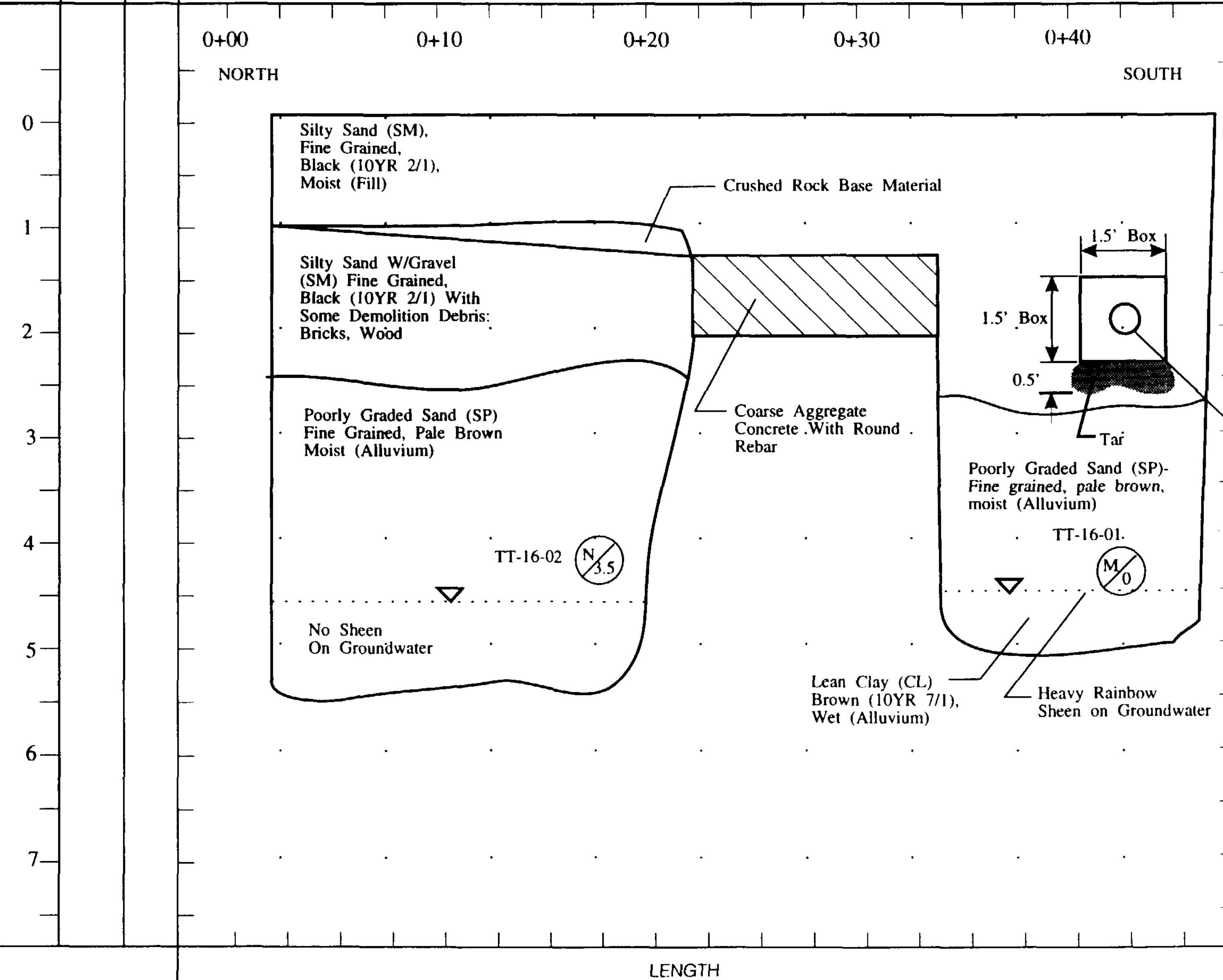
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF E WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/12/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 48' WIDTH 3-4' DEPTH 5' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

End of Trench @ 0 + 48S

4" Stainless Steel Pipe In Wooden Box-Duct

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-17 SHEET 1 OF 2

TEST PIT WALL LOG

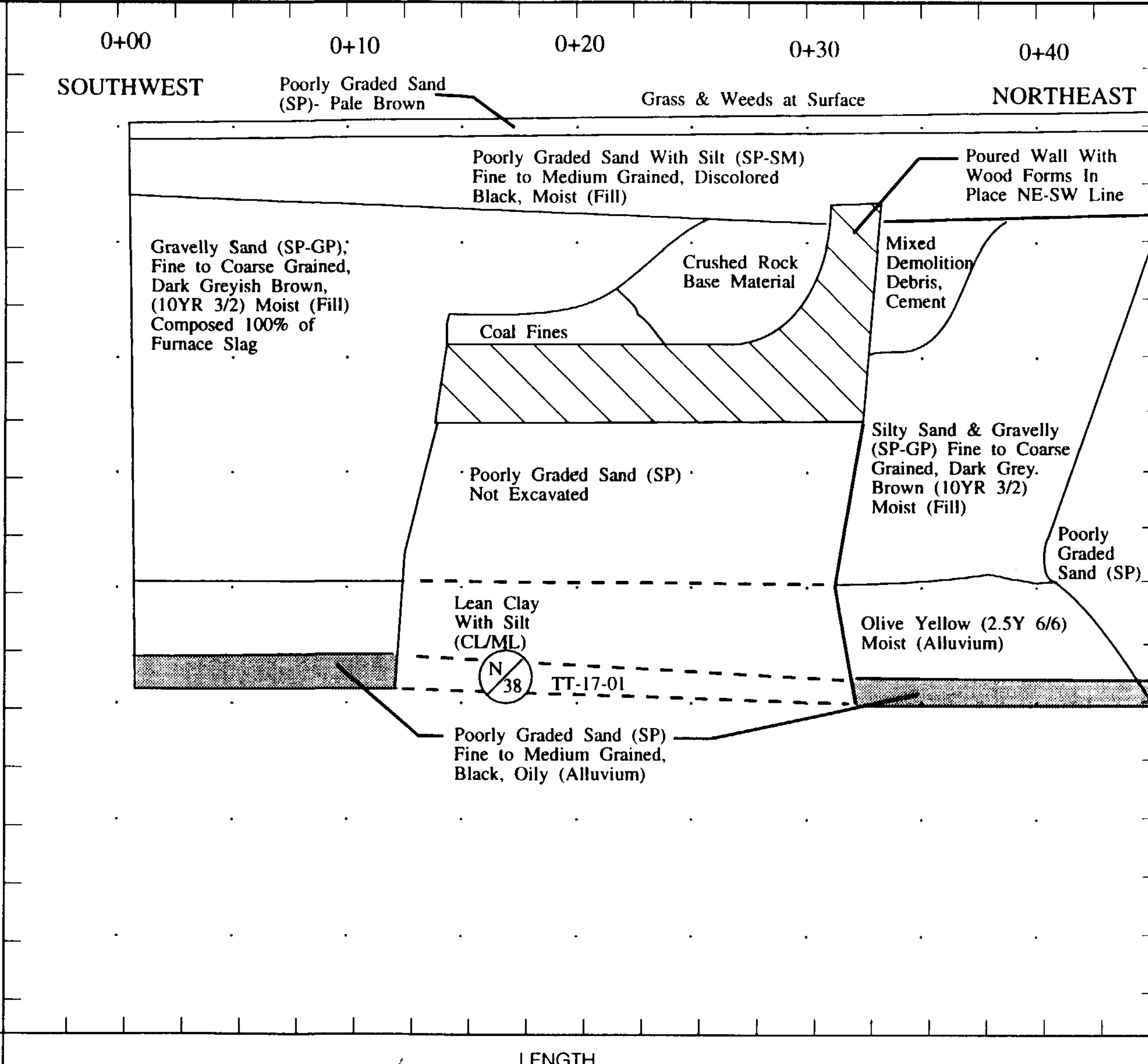
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF SE WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/12/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 80' WIDTH 3-4' DEPTH 5-6' REMARKS ______

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE: TYPE AND NUMBER	SAMPLE: INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M 10

Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Poorly Graded Sand (SP), Fine to Medium Grained, Pale Brown (10YR) Moist, (Alluvium)

Heavy Rainbow Sheen On Groundwater

0+00 to 0+45 Groundwater May Be Confined Below Clay Layer

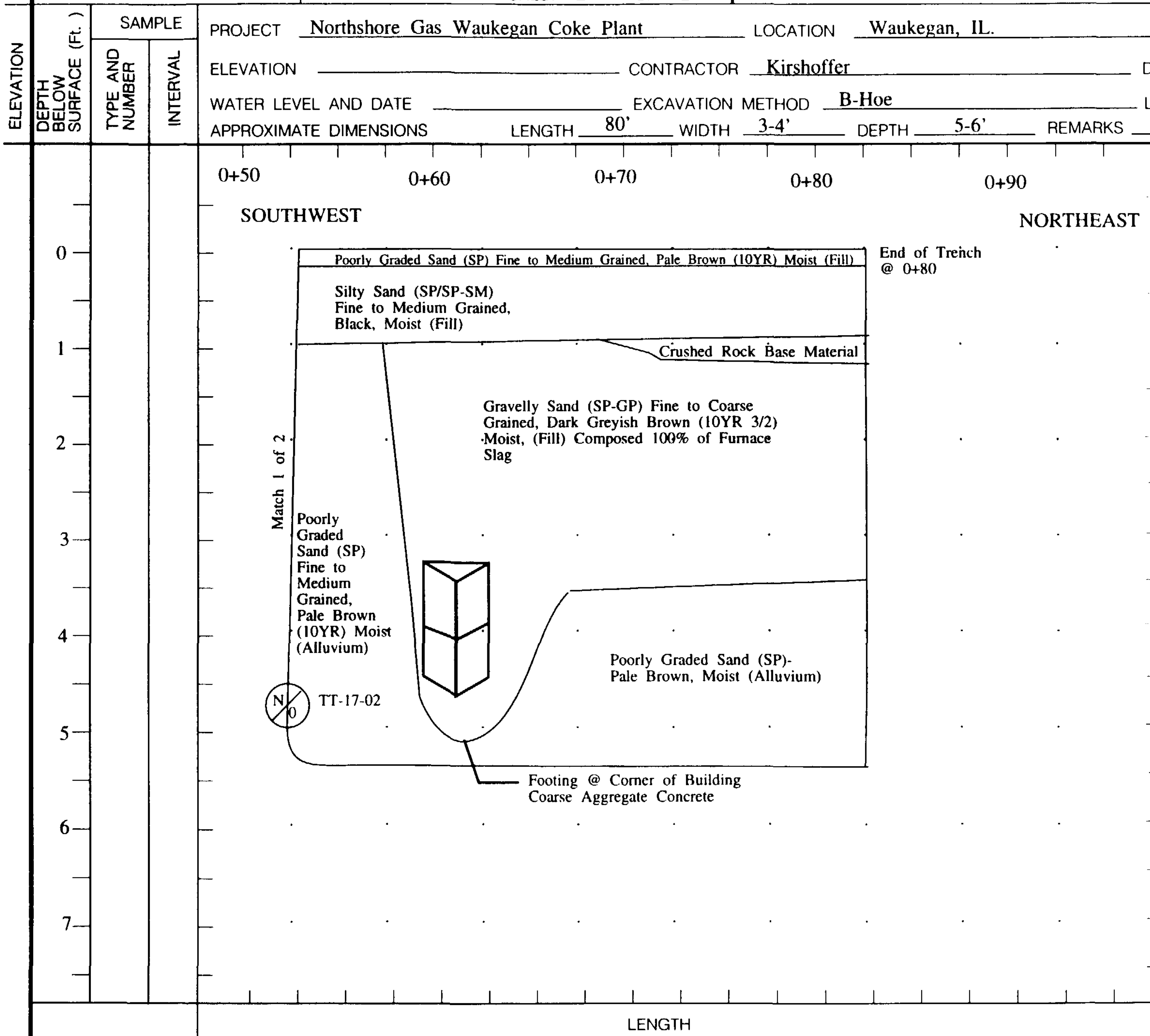
PROJECT NO.	TEST PIT NO.	
13/49-003JSL	TT-17 SHEET 2 OF 2	**TEST PIT WALL LOG**

PROJECT: Northshore Gas Waukegan Coke Plant
LOCATION: Waukegan, IL.
MAP OF SE WALL OF PIT

ELEVATION:
CONTRACTOR: Kirshoffer
DATE EXCAVATED: 3/12/92

WATER LEVEL AND DATE:
EXCAVATION METHOD: B-Hoe
LOGGER: JMF

APPROXIMATE DIMENSIONS: LENGTH 80' WIDTH 3-4' DEPTH 5-6'
REMARKS:



COMMENTS

Spoon Test Location and Result:

M/10

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

Headspace Reading, ppm

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-18 SHEET 1 OF 1

TEST PIT WALL LOG

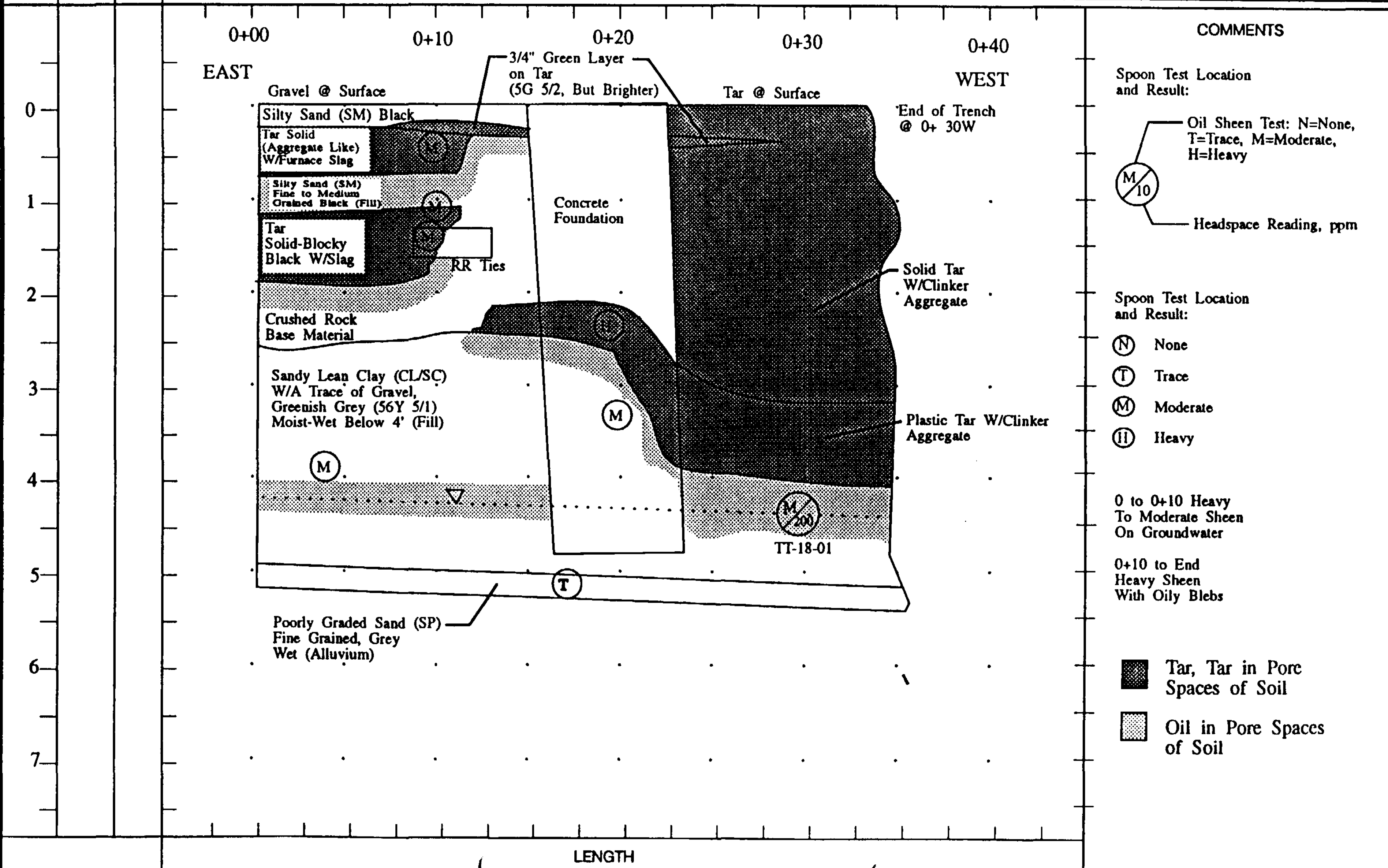
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/17/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 30' WIDTH 3-4' DEPTH 5.5' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-19 SHEET 1 OF 2

TEST PIT WALL LOG

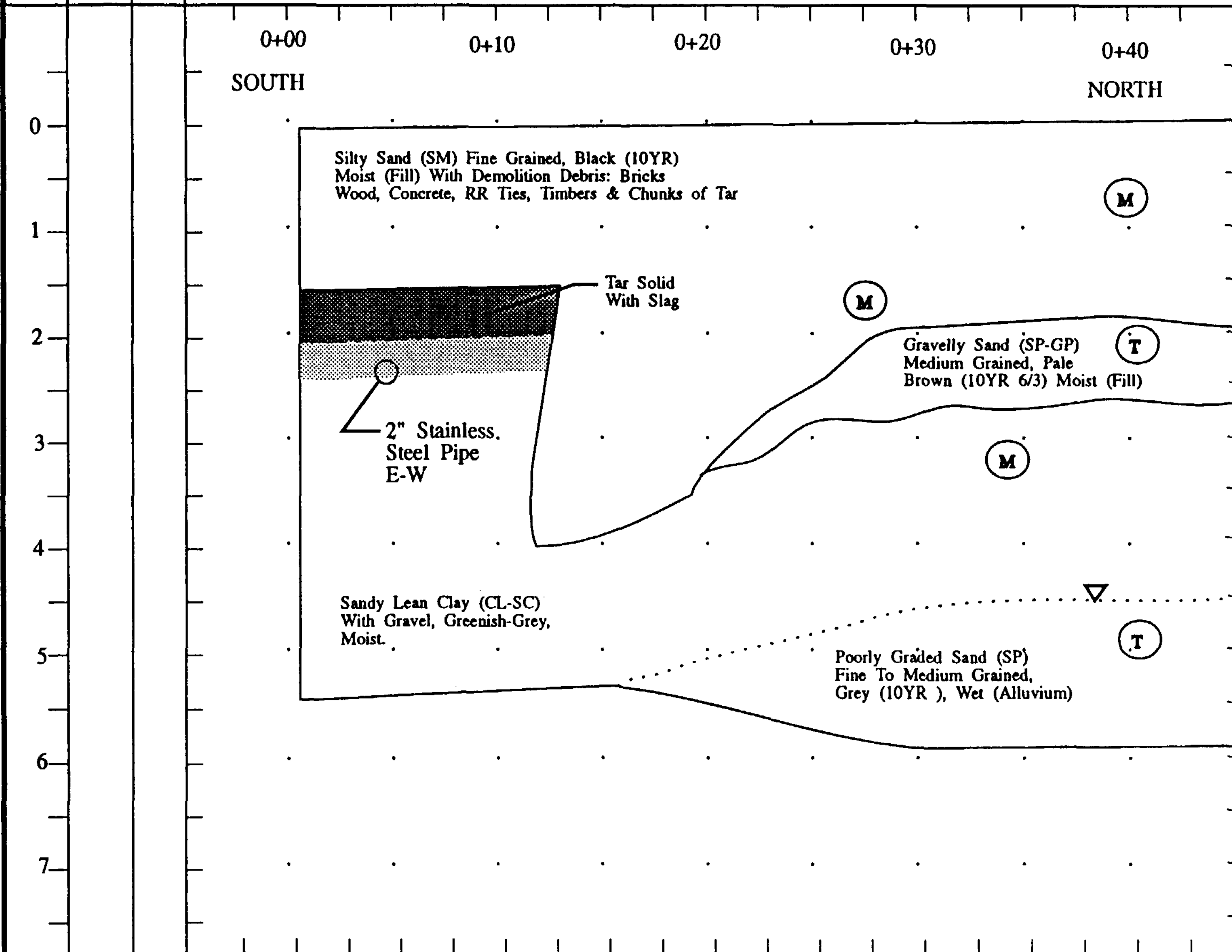
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF W WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/17/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 70' WIDTH 3-4' DEPTH 6' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

- (N) None
- (T) Trace
- (M) Moderate
- (H) Heavy

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Rainbow Sheen on Groundwater

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-19 SHEET 2 OF 2	TEST PIT WALL LOG

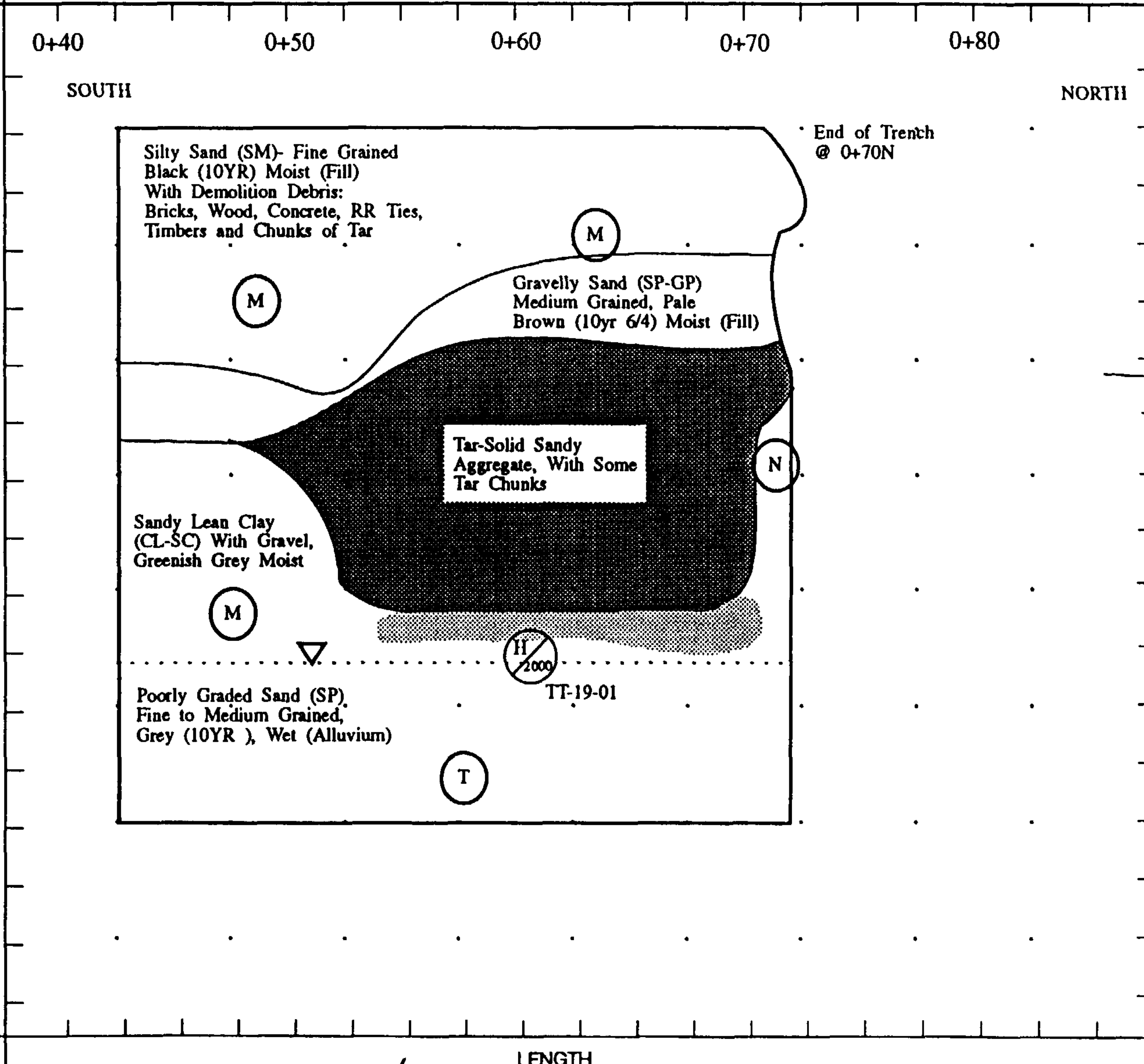
PROJECT: Northshore Gas Waukegan Coke Plant — LOCATION: Waukegan, IL. — MAP OF W WALL OF PIT

ELEVATION: — CONTRACTOR: Kirshoffer — DATE EXCAVATED: 3/17/92

WATER LEVEL AND DATE: — EXCAVATION METHOD: B-Hoe — LOGGER: JMF

APPROXIMATE DIMENSIONS: LENGTH 70' — WIDTH 3-4' — DEPTH 6' — REMARKS:

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Spoon Test Location and Result:

- N None
- T Trace
- M Moderate
- H Heavy

Heavy Oil Sheen on Groundwater With a Trace of Golden Brown Oily Blebs

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

PROJECT NO.	TEST PIT NO.	
13/49-003JSL	TT-19W SHEET 1 OF 4	**TEST PIT WALL LOG**

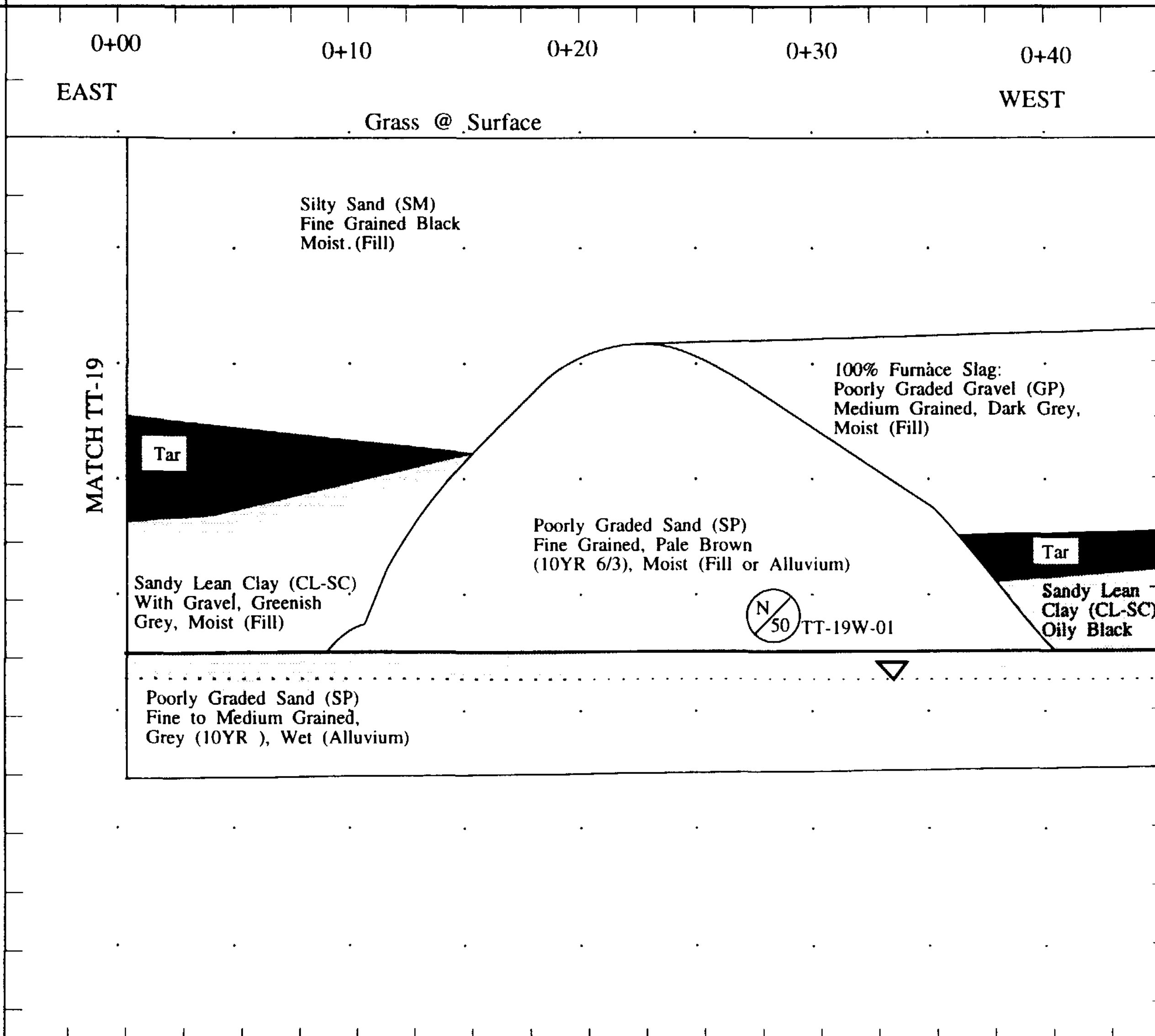
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/17/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 150' WIDTH 3-4' DEPTH 5-6' REMARKS ______

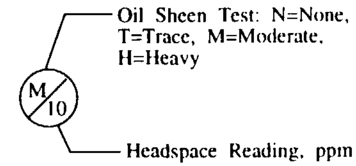
ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE: TYPE AND NUMBER	SAMPLE: INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



LENGTH

COMMENTS

Spoon Test Location and Result:



Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Oil Sheen on Groundwater 0 to 0+20

Moderate Oil Sheen on Groundwater 0+20 to 0+36'

Heavy Oil Sheen on Groundwater 0+36' to End

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-19W SHEET 2 OF 4	**TEST PIT WALL LOG**

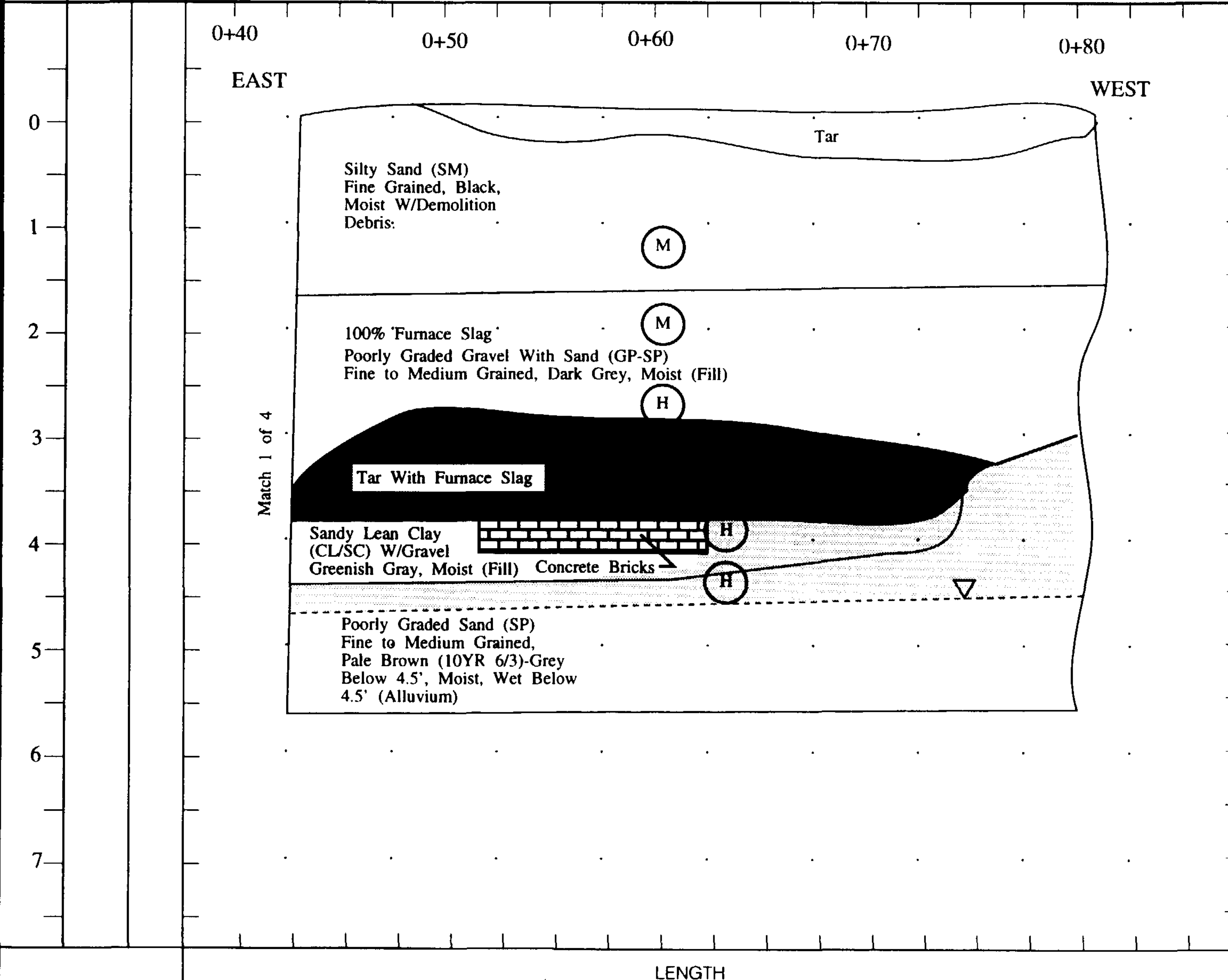
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/17/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 150' WIDTH 3-4' DEPTH 5-6' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

- (N) None
- (T) Trace
- (M) Moderate
- (H) Heavy

■ Tar, Tar in Pore Spaces of Soil

□ Oil in Pore Spaces of Soil

Heavy Rainbow Sheen On Ground Water

PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-19W SHEET 3 OF 4	

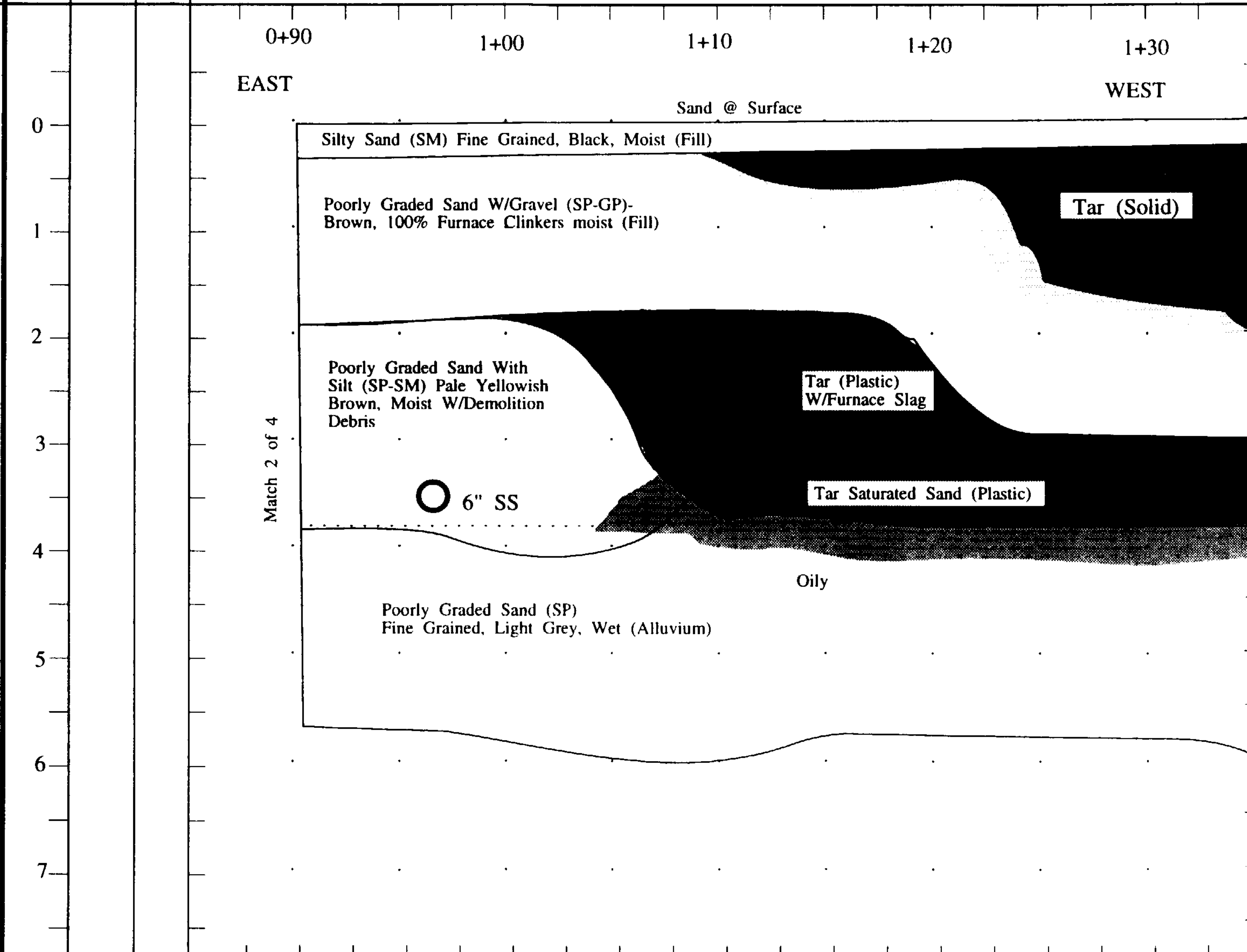
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF S WALL OF PIT

ELEVATION CONTRACTOR Kirshoffer DATE EXCAVATED 3/20/92

WATER LEVEL AND DATE EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 160' WIDTH 3-4' DEPTH 5-6' REMARKS

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



LENGTH

COMMENTS

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Groundwater @ 3.5-4.0' W/Heavy Oil Sheen and Oily Blebs

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-19W — SHEET 4 OF 4

TEST PIT WALL LOG

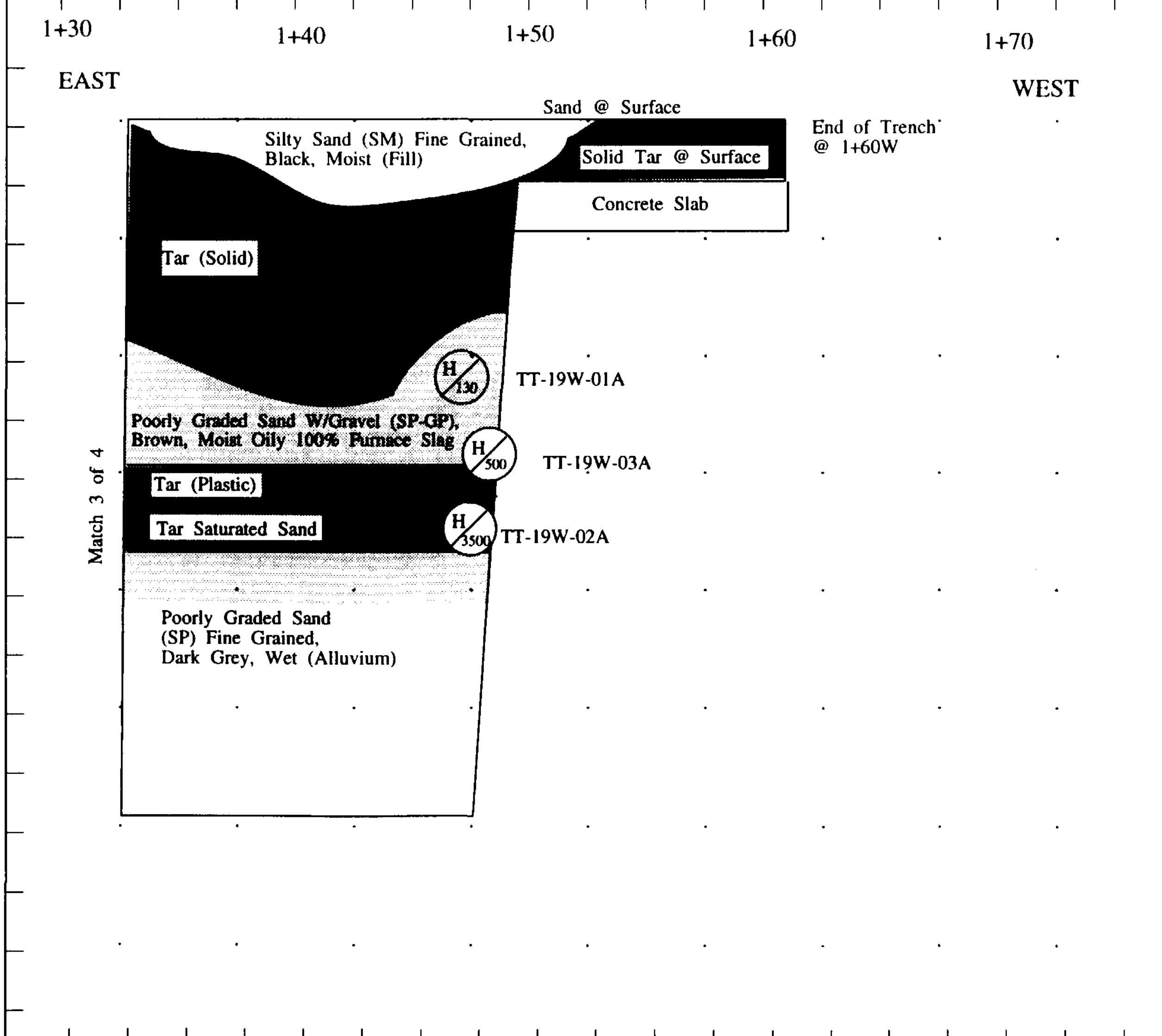
PROJECT: Northshore Gas Waukegan Coke Plant — LOCATION: Waukegan, IL. — MAP OF S WALL OF PIT

ELEVATION: ______ — CONTRACTOR: Kirshoffer — DATE EXCAVATED: 3/20/92

WATER LEVEL AND DATE: ______ — EXCAVATION METHOD: B-Hoe — LOGGER: JMF

APPROXIMATE DIMENSIONS: LENGTH 160' — WIDTH 3-4' — DEPTH 5-6' — REMARKS: ______

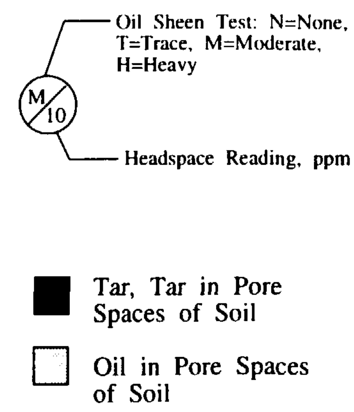
ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE TYPE AND NUMBER	SAMPLE INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



LENGTH

COMMENTS

Spoon Test Location and Result:



Heavy Sheen On Groundwater W/ Oily Blebs

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-20 SHEET 1 OF 2	**TEST PIT WALL LOG**

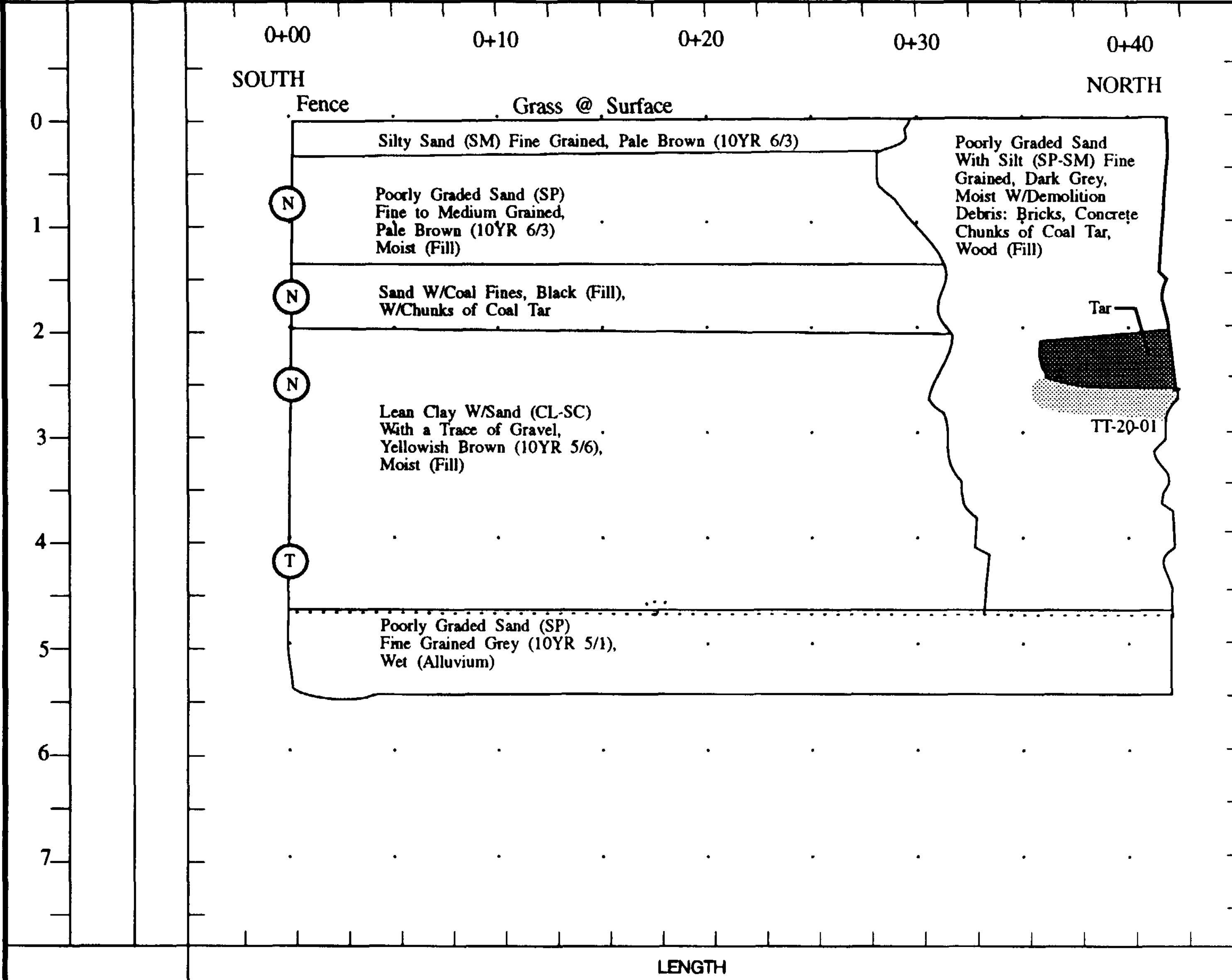
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF E WALL OF PIT

ELEVATION CONTRACTOR Kirshoffer DATE EXCAVATED 3/16/92

WATER LEVEL AND DATE EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 60' WIDTH 3-4' DEPTH 5 - 5.5' REMARKS

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Spoon Test Location and Result:

N None

T Trace

M Moderate

H Heavy

Moderate Sheen on Groundwater Heavy Sheen @ 0+20

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-20 SHEET 2 OF 2	TEST PIT WALL LOG

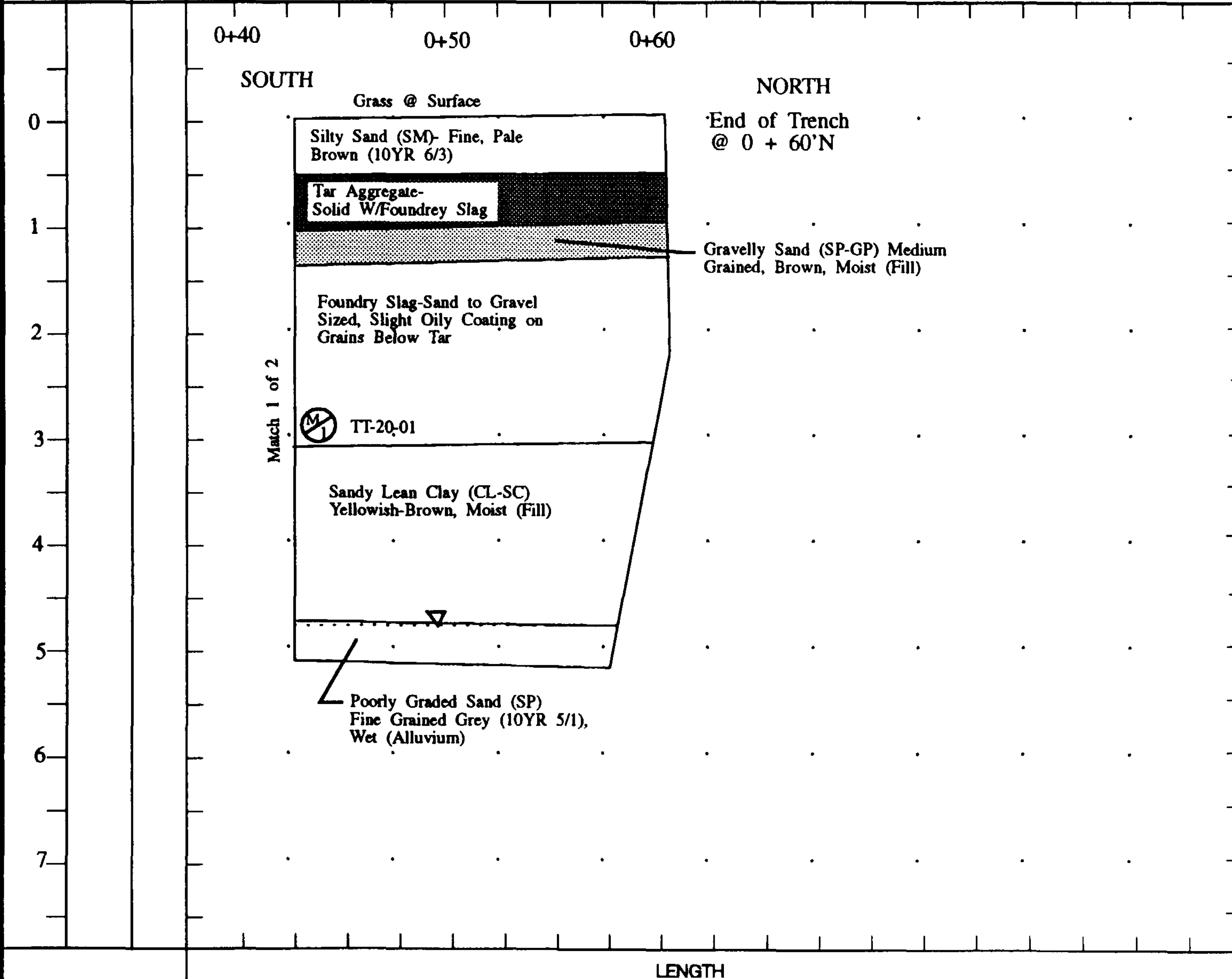
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF E WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/16/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 60' WIDTH 3-4' DEPTH 5 - 5.5' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

M 10

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

PROJECT NO. 13/49-003JSL | TEST PIT NO. TT-21 | SHEET 1 OF 1

TEST PIT WALL LOG

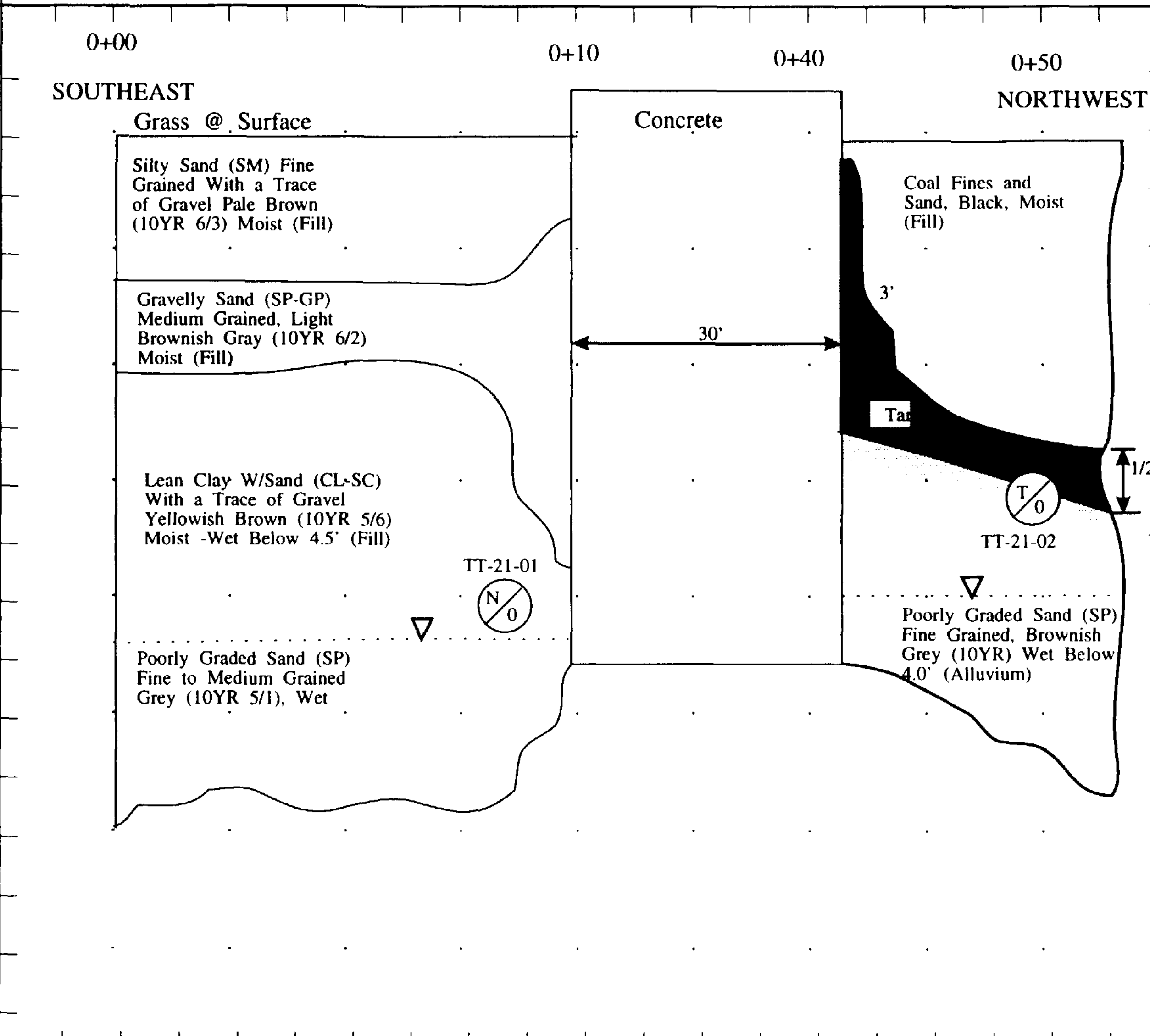
PROJECT Northshore Gas Waukegan Coke Plant
LOCATION Waukegan, IL.
MAP OF NE WALL OF PIT

ELEVATION
CONTRACTOR Kirshoffer
DATE EXCAVATED 3/16/92

WATER LEVEL AND DATE
EXCAVATION METHOD B-Hoe
LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 50' WIDTH 3-4' DEPTH 5-6'
REMARKS

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE: TYPE AND NUMBER	SAMPLE: INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



LENGTH

COMMENTS

End of Trench @ 0 +50' NW

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Rainbow Sheen on Groundwater

PROJECT NO.	TEST PIT NO.	
13/49-003JSL	TT-22 SHEET 1 OF 2	**TEST PIT WALL LOG**

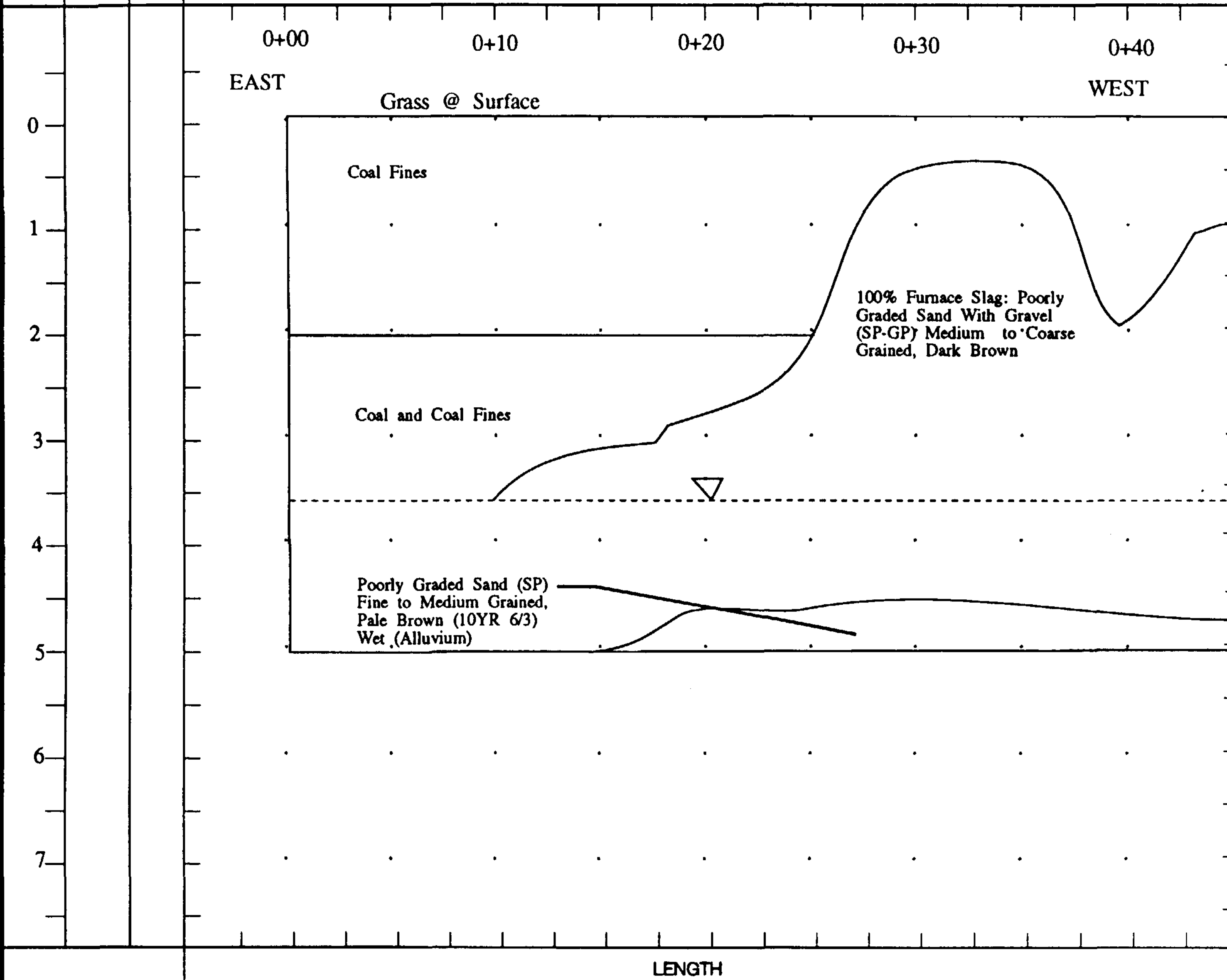
PROJECT: Northshore Gas Waukegan Coke Plant LOCATION: Waukegan, IL. MAP OF N WALL OF PIT

ELEVATION: CONTRACTOR: Kirshoffer DATE EXCAVATED: 3/12/92

WATER LEVEL AND DATE: EXCAVATION METHOD: B-Hoe LOGGER: JMF

APPROXIMATE DIMENSIONS LENGTH 65' WIDTH 3-4' DEPTH 5' REMARKS

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



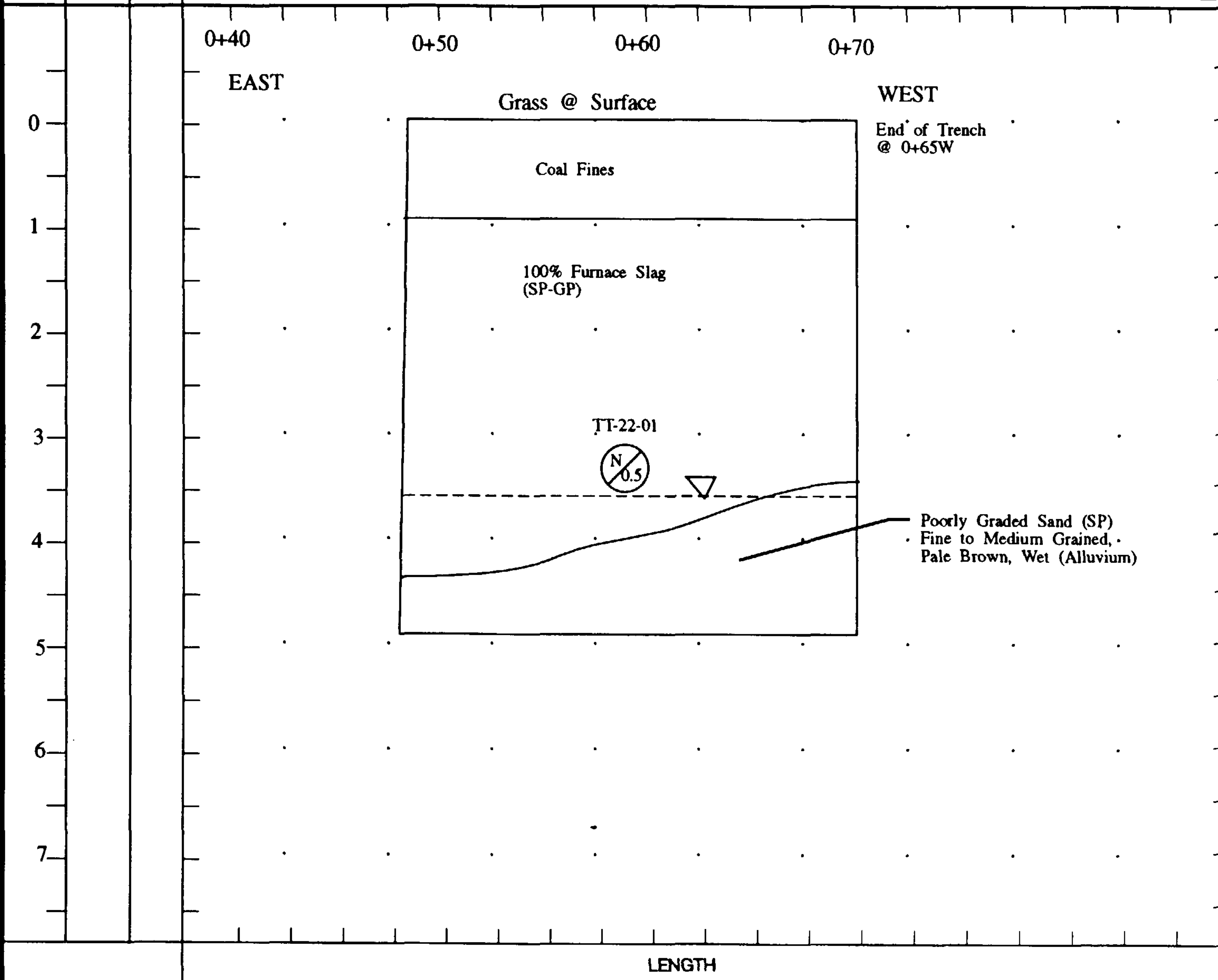
COMMENTS

Heavy Sheen on Groundwater 0+30 to 0+50

TEST PIT WALL LOG

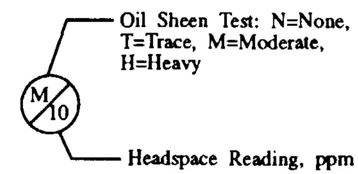
PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-22	SHEET 2 OF 2	
PROJECT Northshore Gas Waukegan Coke Plant	LOCATION Waukegan, IL.	MAP OF N WALL OF PIT	
ELEVATION	CONTRACTOR Kirshoffer	DATE EXCAVATED 3/12/92	
WATER LEVEL AND DATE	EXCAVATION METHOD B-Hoe	LOGGER JMF	
APPROXIMATE DIMENSIONS	LENGTH 65'	WIDTH 3-4'	DEPTH 5' REMARKS

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

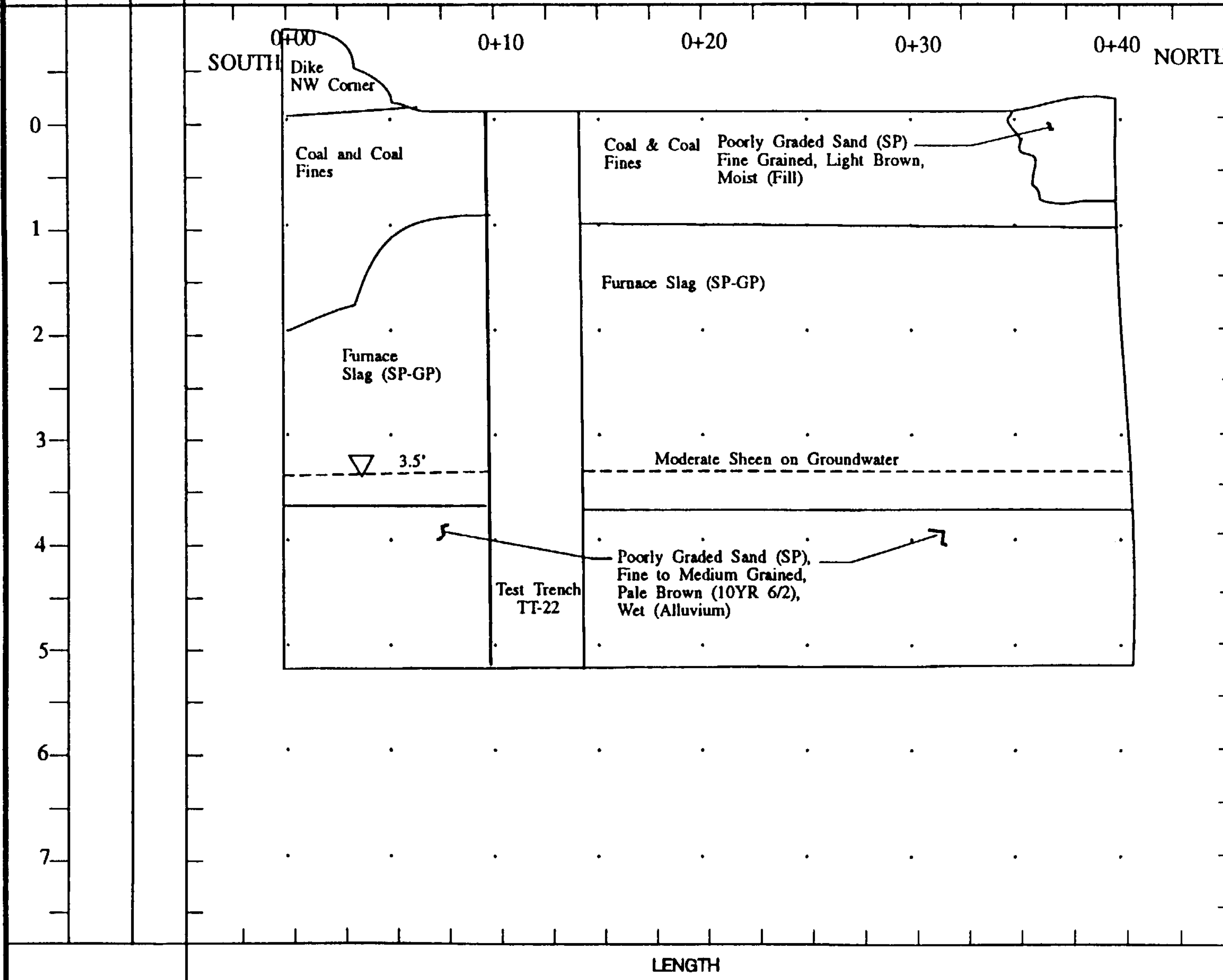
Spoon Test Location and Result:



PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-22N SHEET 1 OF 2	

PROJECT: Northshore Gas Waukegan Coke Plant
LOCATION: Waukegan, IL.
MAP OF: W WALL OF PIT
ELEVATION:
CONTRACTOR: Kirshoffer
DATE EXCAVATED: 3/12/92
WATER LEVEL AND DATE:
EXCAVATION METHOD: B-Hoe
LOGGER: JMF
APPROXIMATE DIMENSIONS: LENGTH 60' WIDTH 3-4' DEPTH 5'
REMARKS:

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER, INTERVAL | COMMENTS



PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-22N SHEET 2 OF 2	

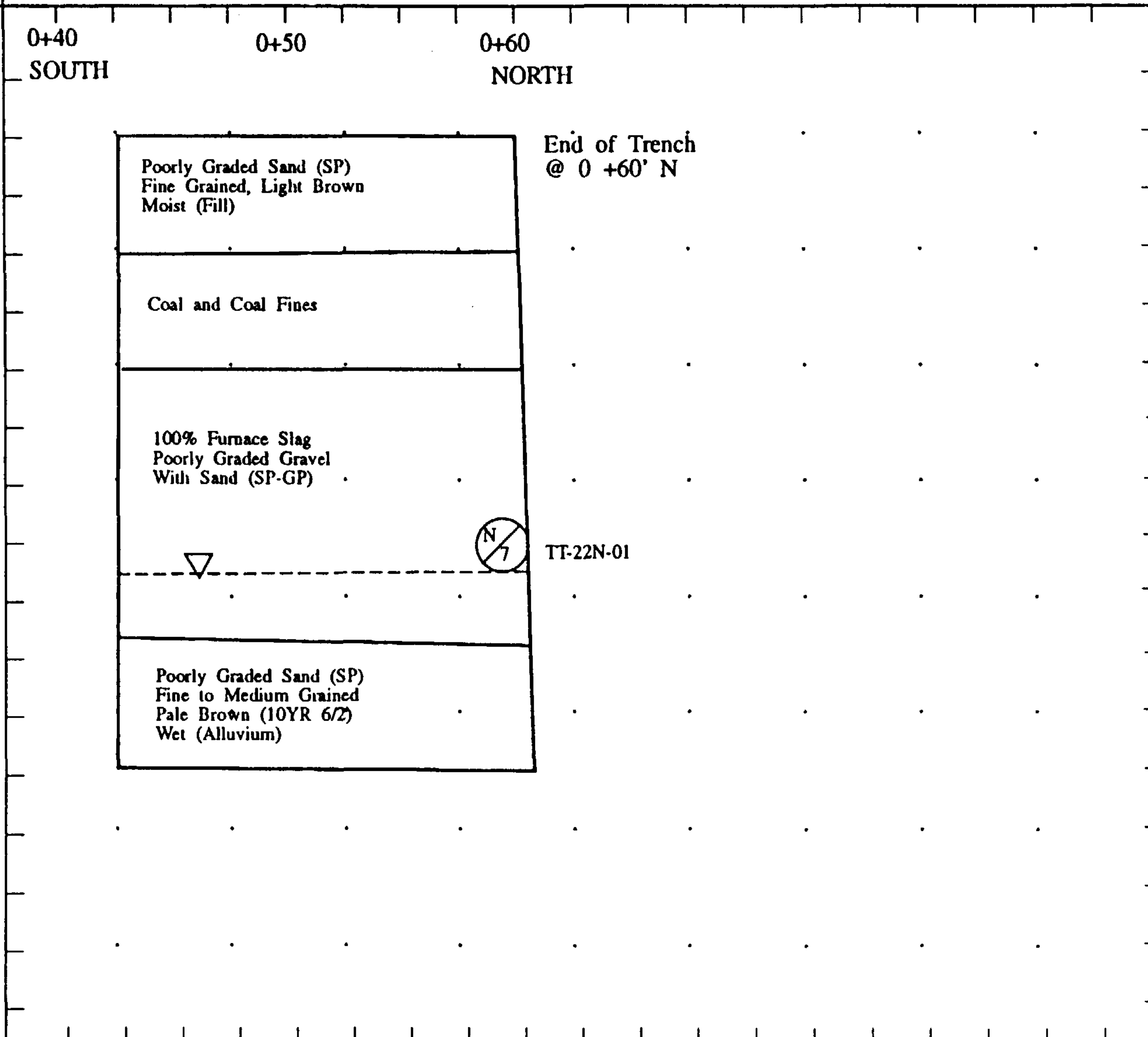
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF W WALL OF PIT

ELEVATION CONTRACTOR Kirshoffer DATE EXCAVATED 3/12/92

WATER LEVEL AND DATE EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 60' WIDTH 3-4' DEPTH 5' REMARKS

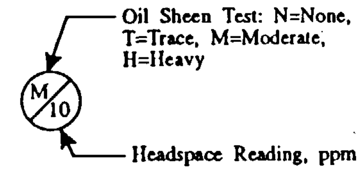
ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE: TYPE AND NUMBER	SAMPLE: INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



LENGTH

COMMENTS

Spoon Test Location
and Result:



TEST PIT WALL LOG

PROJECT NO.	TEST PIT NO.		
13/49-003JSL	TT-23	SHEET 1	OF 1

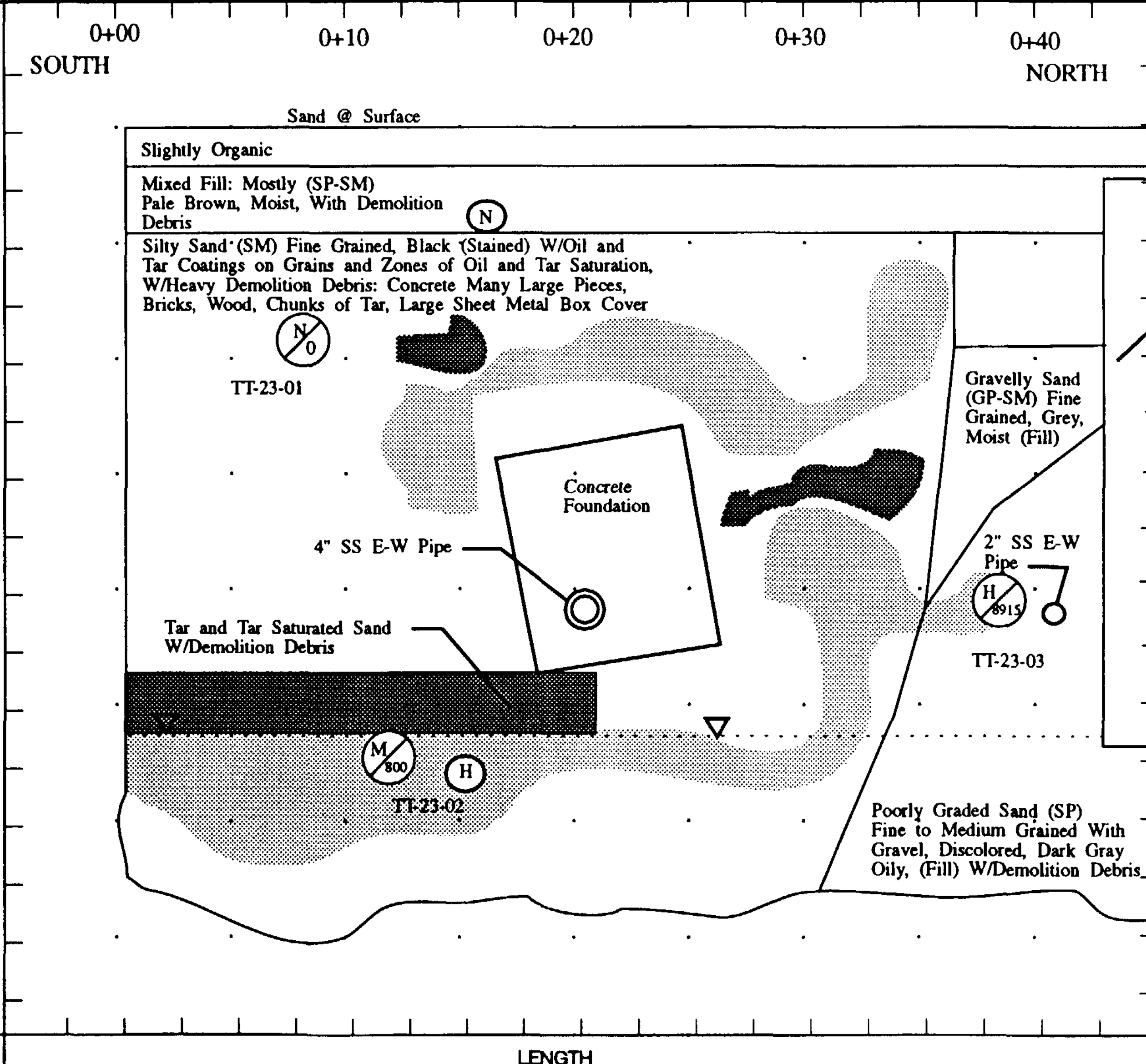
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF E WALL OF PIT

ELEVATION CONTRACTOR Kirshoffer DATE EXCAVATED 3/19/92

WATER LEVEL AND DATE EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 50' WIDTH 10-70' DEPTH 7' REMARKS

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE TYPE AND NUMBER	SAMPLE INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M/10

Headspace Reading, ppm

Poured Concrete Wall E-W @ End of Trench

Spoon Test Location and Result:

- N None
- T Trace
- M Moderate
- H Heavy

Groundwater @ 5' With Heavy Sheen and Oily Blebs From 0+00 to 0+35

- Tar, Tar in Pore Spaces of Soil
- Oil in Pore Spaces of Soil

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-00A SHEET 1 OF 1	TEST PIT WALL LOG

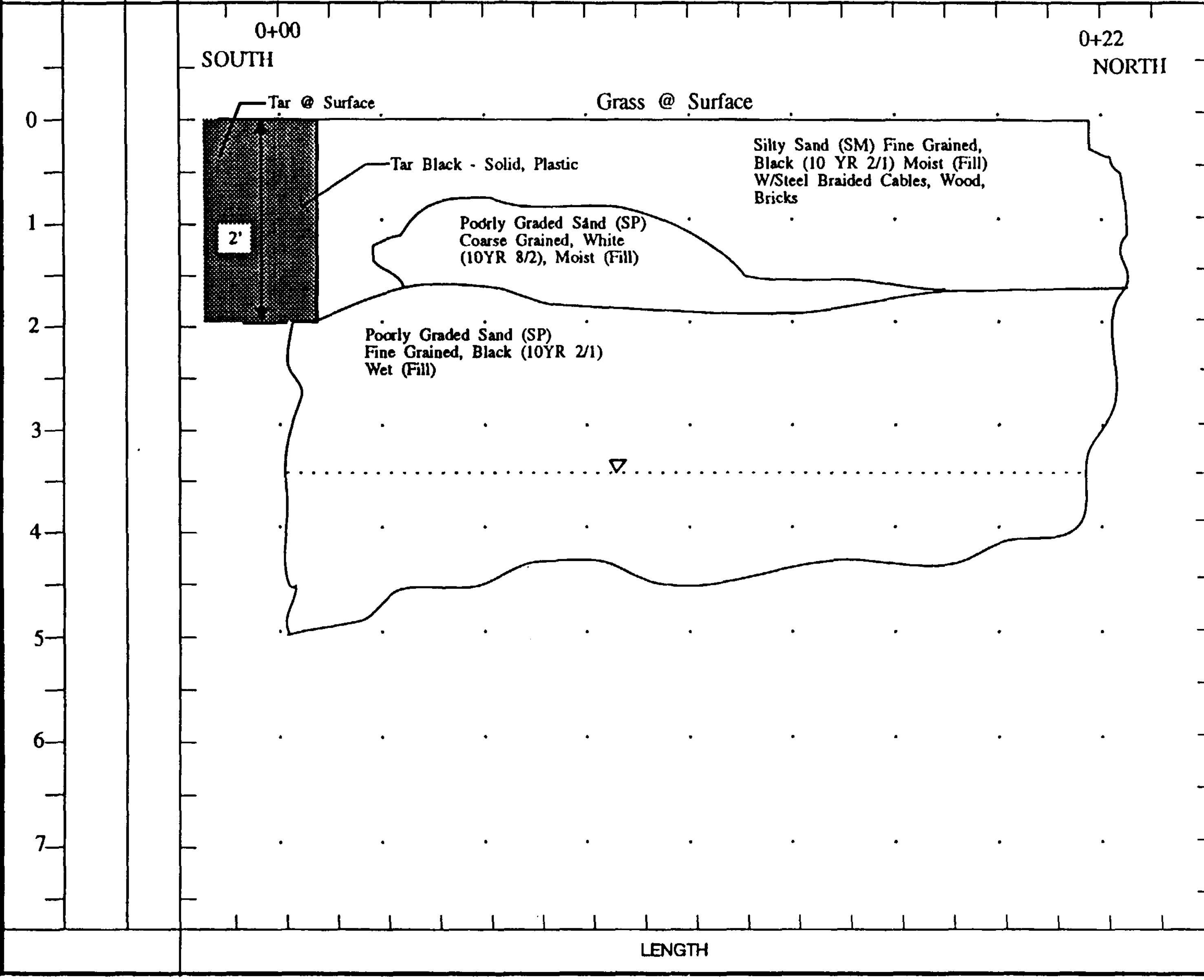
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF W WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/11/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 22' WIDTH 3-4' DEPTH 4-5' REMARKS ______

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-00C SHEET 1 OF 3

TEST PIT WALL LOG

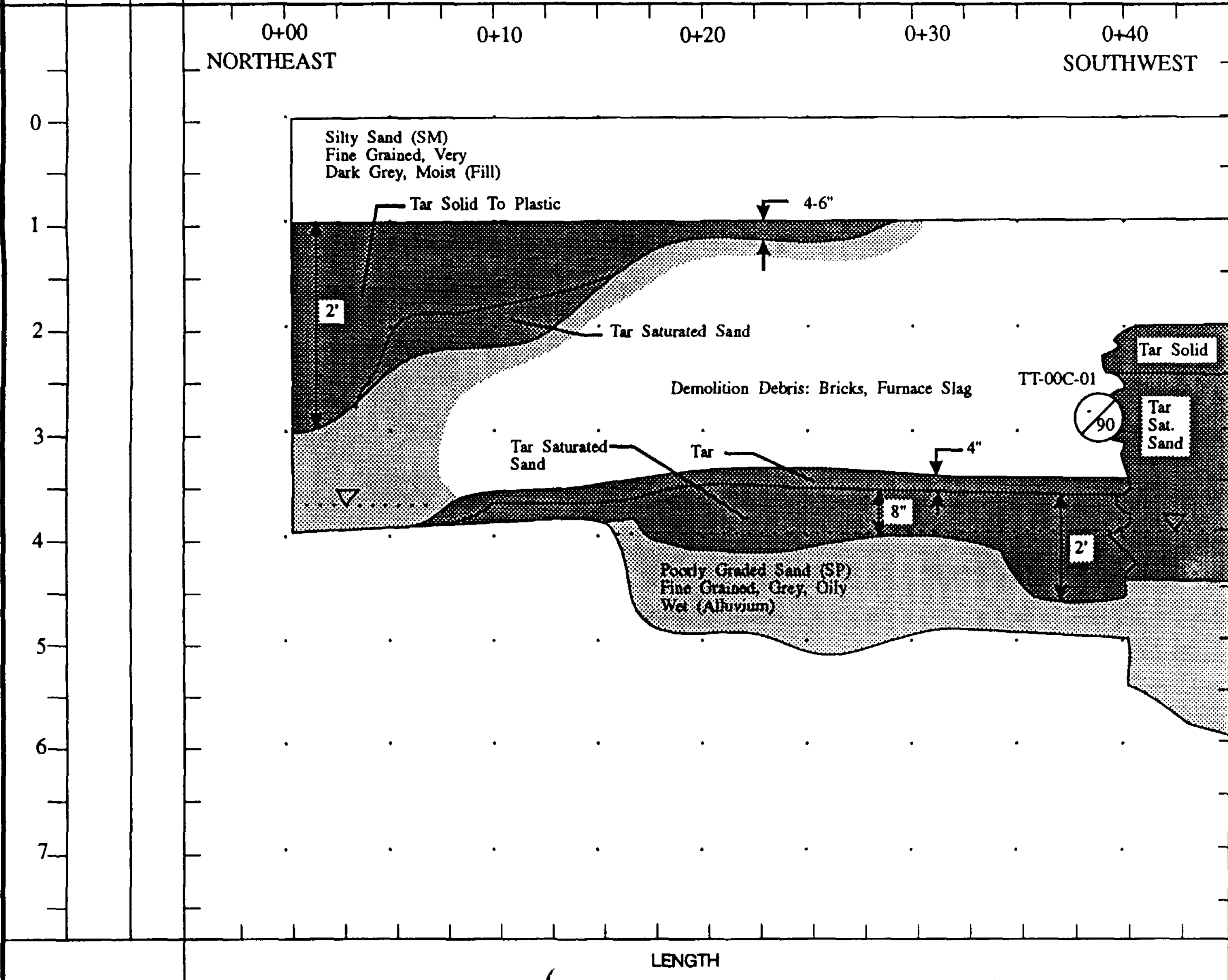
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF SE WALL OF PIT

ELEVATION ________ CONTRACTOR Kirshoffer DATE EXCAVATED 3/20/92

WATER LEVEL AND DATE ________ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 100' WIDTH 3-4' DEPTH 4-6' REMARKS ________

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

M / 10

Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Sheen on Groundwater With Golden-Brown Oily Blebs

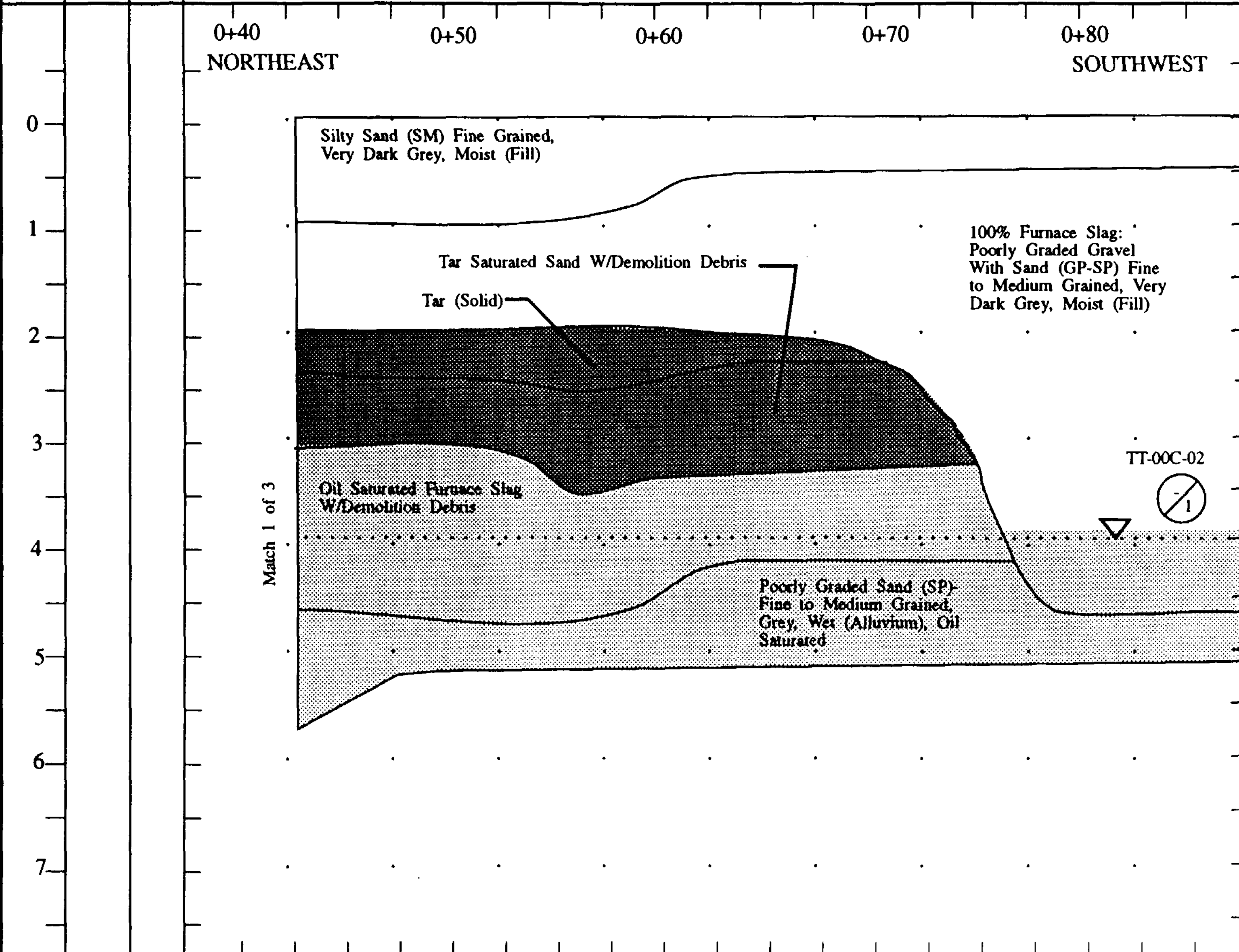
PROJECT NO. 13/49-003JSL

TEST PIT NO. TT-00C SHEET 2 OF 3

TEST PIT WALL LOG

PROJECT	Northshore Gas Waukegan Coke Plant
LOCATION	Waukegan, IL.
MAP OF	SE WALL OF PIT
ELEVATION	
CONTRACTOR	Kirshoffer
DATE EXCAVATED	3/20/92
WATER LEVEL AND DATE	
EXCAVATION METHOD	B-Hoe
LOGGER	JMF
APPROXIMATE DIMENSIONS	LENGTH 100' WIDTH 3-4' DEPTH 4-6'
REMARKS	

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Spoon Test Location and Result:

Oil Sheen Test: N=None, T=Trace, M=Moderate, H=Heavy

Headspace Reading, ppm

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Sheen on Groundwater With Golden-Brown Oily Blebs

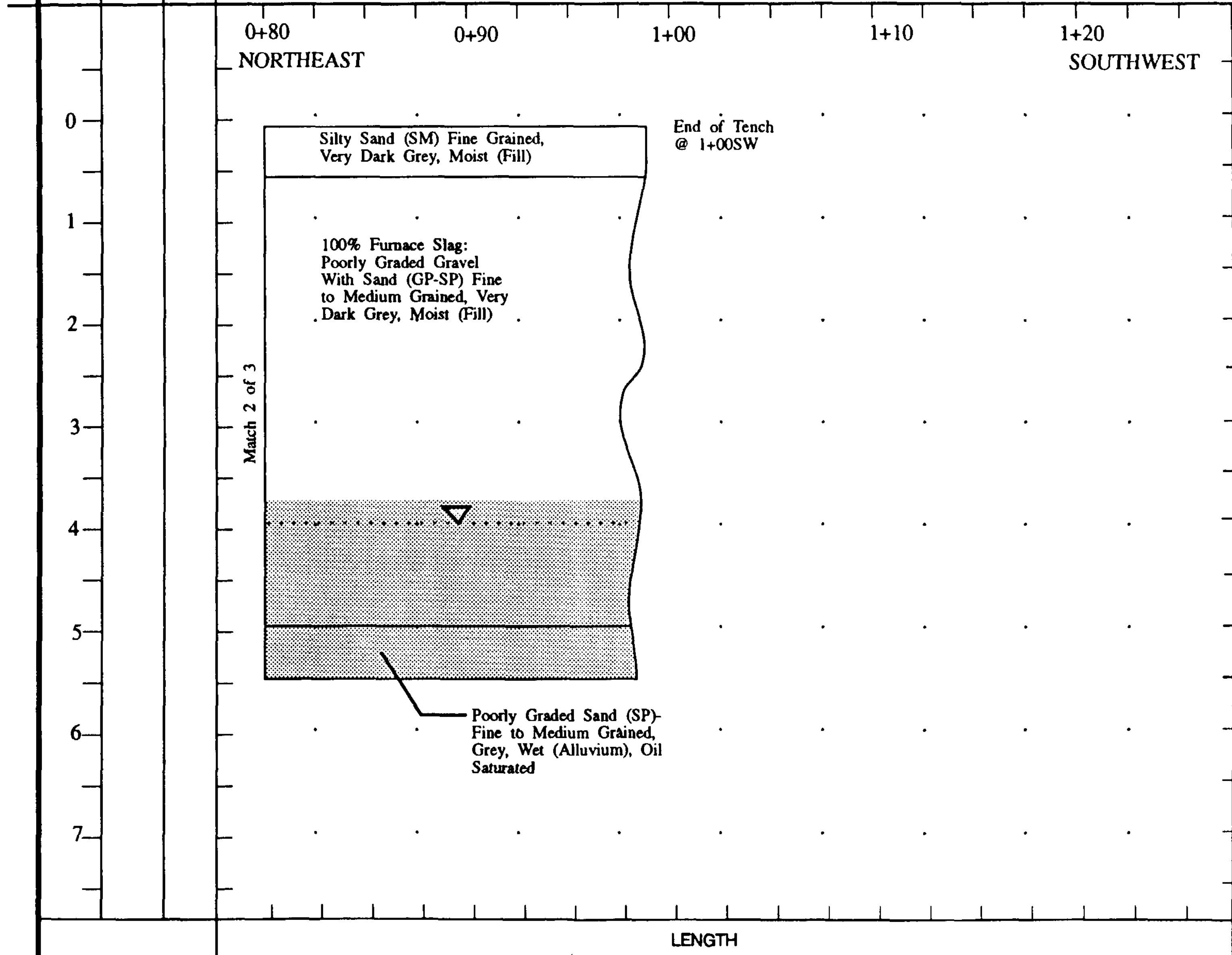
PROJECT NO.	TEST PIT NO.	
13/49-003JSL	TT-00C SHEET 3 OF 3	**TEST PIT WALL LOG**

PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF SE WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/20/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 100' WIDTH 3-4' DEPTH 4-6' REMARKS ______



COMMENTS

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Sheen on Groundwater With Brown Oily Blebs

PROJECT NO. 13/49-003JSL	TEST PIT NO. TT-00D SHEET 1 OF 3	TEST PIT WALL LOG

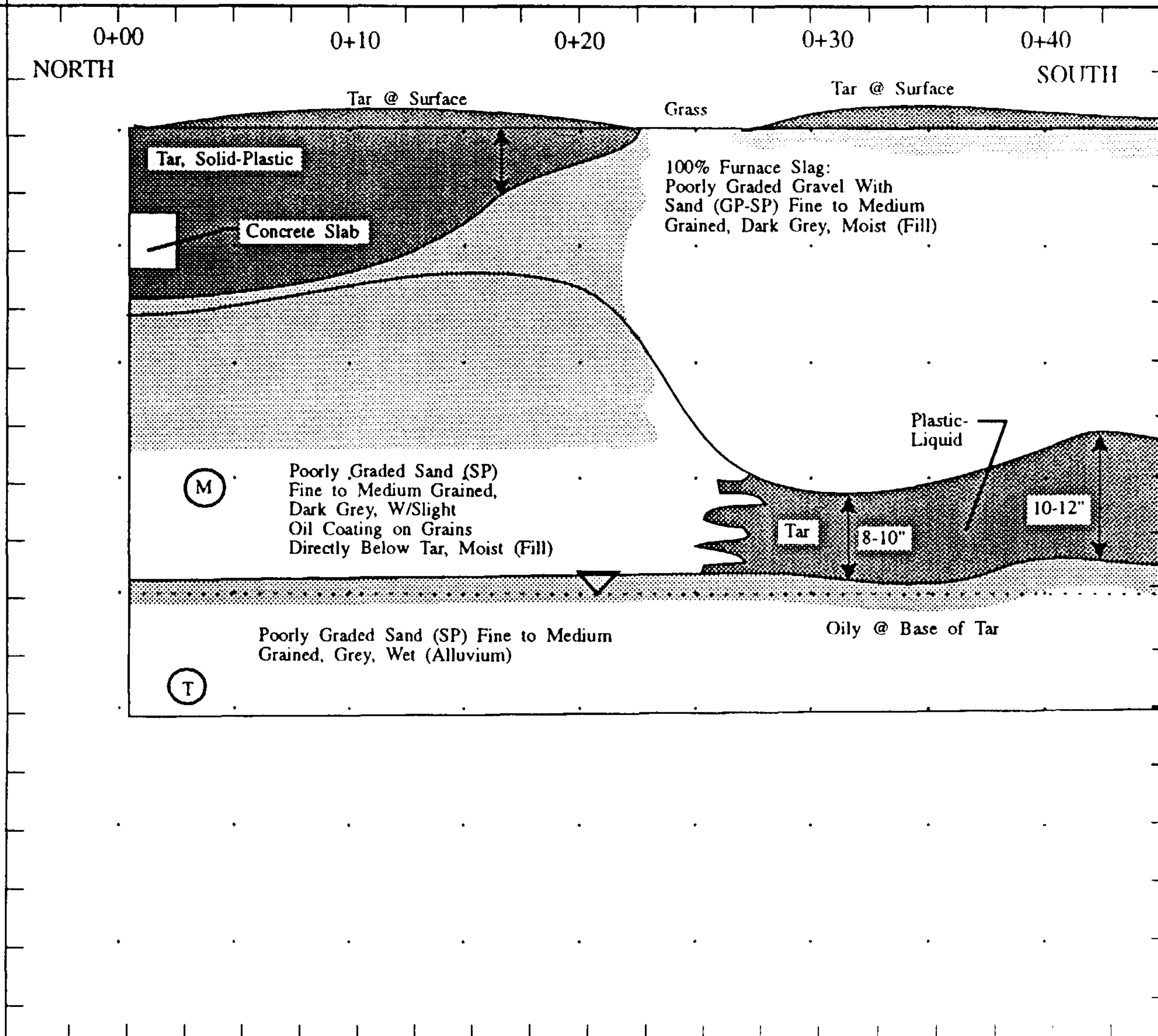
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF W WALL OF PIT

ELEVATION ______ CONTRACTOR Kirshoffer DATE EXCAVATED 3/20/92

WATER LEVEL AND DATE ______ EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 100' WIDTH 3-4' DEPTH 5' REMARKS ______

ELEVATION	DEPTH BELOW SURFACE (Ft.)	SAMPLE TYPE AND NUMBER	SAMPLE INTERVAL
	0		
	1		
	2		
	3		
	4		
	5		
	6		
	7		



LENGTH

COMMENTS

Spoon Test Location and Result:

(N) None

(T) Trace

(M) Moderate

(H) Heavy

Tar, Tar in Pore Spaces of Soil

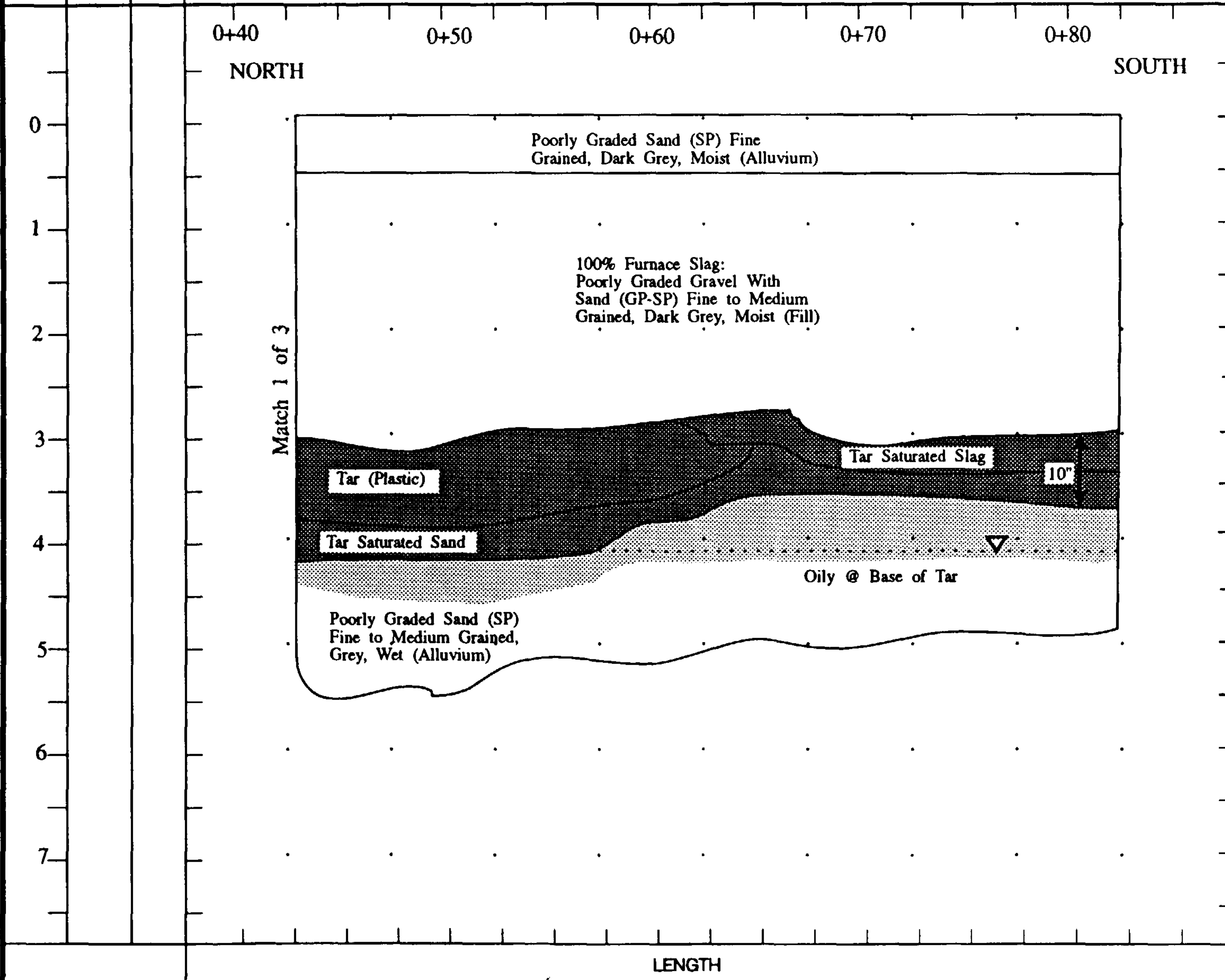
Oil in Pore Spaces of Soil

Heavy Oil Sheen on Groundwater With a Trace of Golden Brown Oily Blebs

PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-00D SHEET 2 OF 3	

PROJECT	Northshore Gas Waukegan Coke Plant
LOCATION	Waukegan, IL.
MAP OF	W WALL OF PIT
ELEVATION	
CONTRACTOR	Kirshoffer
DATE EXCAVATED	3/20/92
WATER LEVEL AND DATE	
EXCAVATION METHOD	B-Hoe
LOGGER	JMF
APPROXIMATE DIMENSIONS	LENGTH 100' WIDTH 3-4' DEPTH 5'
REMARKS	

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Oil Sheen on Groundwater With a Trace of Golden Brown Oily Blebs

PROJECT NO.	TEST PIT NO.	TEST PIT WALL LOG
13/49-003JSL	TT-00D SHEET 3 OF 3	

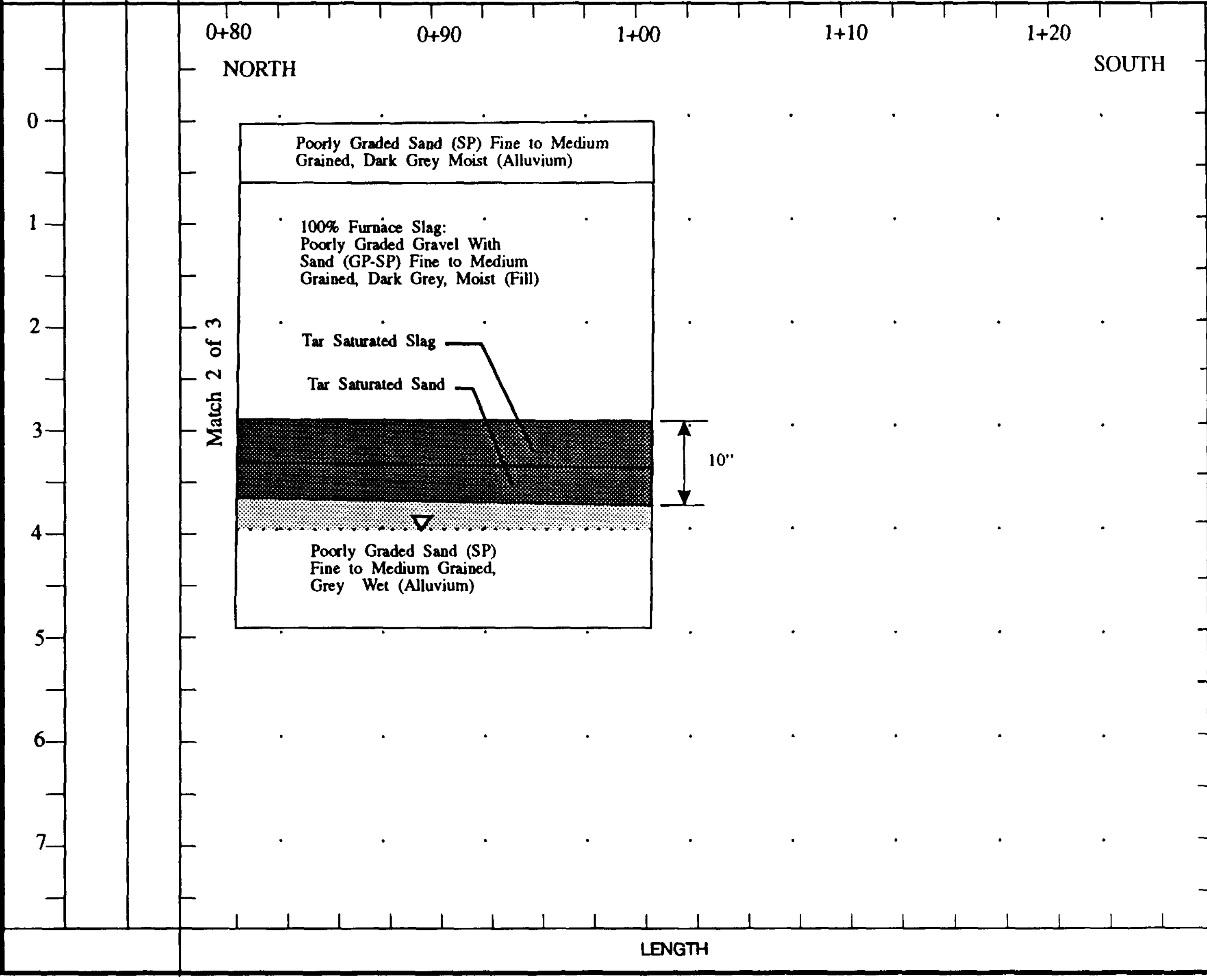
PROJECT Northshore Gas Waukegan Coke Plant LOCATION Waukegan, IL. MAP OF W WALL OF PIT

ELEVATION CONTRACTOR Kirshoffer DATE EXCAVATED 3/20/92

WATER LEVEL AND DATE EXCAVATION METHOD B-Hoe LOGGER JMF

APPROXIMATE DIMENSIONS LENGTH 100' WIDTH 3-4' DEPTH 5' REMARKS

ELEVATION | DEPTH BELOW SURFACE (Ft.) | SAMPLE: TYPE AND NUMBER | INTERVAL



COMMENTS

Tar, Tar in Pore Spaces of Soil

Oil in Pore Spaces of Soil

Heavy Oil Sheen on Groundwater With a Trace of Golden Brown Oily Blebs.

Appendix B

Survey Notes

TABLE B-1

WAUKEGAN MANUFACTURED GAS AND COKE PLANT
August 20, 1992

Soil Samples	Elevation	Location Coordinates		Survey Book Page
		North	East	
SS-01	585.4	4971.8	5553.3	26
SS-02	585.3	4920.5	5392.1	4/40
SS-03	585.5	4934.9	5206.2	4/40
SS-04	584.8	4737.9	5064.3	4/40
SS-05	584.6	4740.8	5266.9	4/40
SS-06	585.8	4733.2	5529.7	28
SS-07	584.7	4727.4	5665.5	27
SS-08	585.5	4527.0	5627.6	27
SS-09	586.9	4348.0	5505.0	27
SS-10	585.8	4176.9	5363.0	28
SS-11	585.6	4047.1	5235.5	32
SS-12	583.9	3835.7	5001.2	32
SS-13	585.1	3840.3	5193.6	32
SS-14	585.2	3788.1	5389.9	30
SS-15	585.4	3647.0	5272.4	33
SS-16	585.2	3649.8	5075.4	33
SS-17	585.1	3653.1	4865.6	33
SC-01	584.4	3599.4	5600.9	33
SC-02	585.8	4263.4	5828.9	33
BS-06	586.3	5146.6	4955.6	36
BS-07	584.8	5128.7	5525.8	36
BS-08	585.6	5444.6	6198.8	37
SB-03	585.9	4975.8	5528.3	41

TABLE B-1 (Cont.)

WAUKEGAN MANUFACTURED GAS AND COKE PLANT
August 20, 1992

Monitoring Well	Elevation			Location Coordinates		Survey Book Page
	Ground	Casing	Riser	North	East	
MW-3D	585.5	588.23	588.23	4961.8	5552.0	21/26
MW-3S	585.2	588.31	588.24	4971.8	5553.3	21/26
MW-4D	586.1	589.07	589.06	4118.3	5874.1	34/39
MW-4S	586.2	589.29	589.17	4109.5	5870.6	34/39
MW-5D	585.7	588.49	588.47	3807.9	4811.6	22/32
MW-5S	585.4	587.91	587.89	3802.6	4811.1	23/32
MW-6D	585.7	588.56	588.51	4442.1	4921.0	23/28
MW-6S	585.7	588.48	588.45	4431.7	4920.3	23/28
P-101	585.0	588.21	588.14	4994.2	5036.0	36/41
P-102	585.6	588.57	588.52	4963.9	5958.3	21/26
P-103	586.4	589.47	589.44	4004.9	5467.3	29/39
P-104	586.0	589.10	589.07	4499.9	5574.5	22/27
Existing 1D	585.8	587.74	587.62	4412.7	5326.1	6/24
Existing 1S	586.0	587.83	587.76	4418.1	5328.4	6/24

Bench Mark (BM): "X" on seawall northwest corner of slip at Larson Marine, 7 feet east of and 41 feet south of Larson Marine storage building.

EL. Given = 584.65 Coordinate: 4675N, 4939E

BM was established by Mid America Survey Company in 1988 for Canonie and Hi Tech.

Elevations are USGS mean sea level datum elevations.

WAUKEGAN
COKE
PLANT
1
RI/FS

TELEDYNE
400
LEVEL BOOK

NOTE:
REVISED NAME
AUGUST 26, 1992
PAGES 25 & 38

WAUKEGAN

COKE ~~HARBOR~~ ~~TRUST~~ PLANT

DATE: FEB ~~24~~ 25, 1992

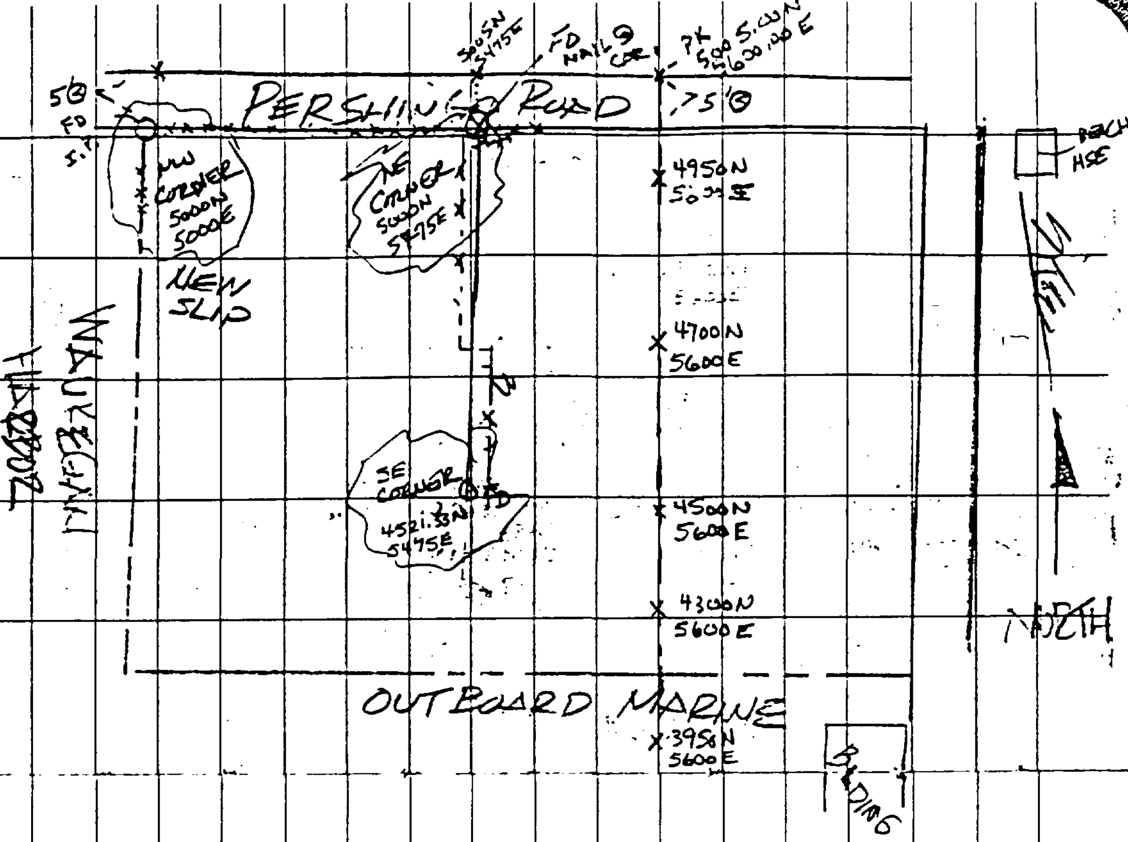
WEATHER: CLOUDY COLD 35°/CHANCE RAIN

CREW: DERRICK MITCHELL
JIM STABERG
~~STEVE M~~

INST: LIETZ TOTAL STATION SET

PURPOSE: 1) SET BASELINE & CONTROL
2) LOCATE SOIL BORING
3) LOCATE TEST TRENCH
4) LOCATE EXISTING & PROPOSED MONITORING WELLS

TIED INTO GIVEN COORD.



SETUP ON 5005 6 LINE 5 5005N 5475E ; SET PK NAIL 125'E ON 5005N 5600E LINE. SETUP ON PK NAIL 5005N 5600E SET: BASELINE, TIED INTO SE CORNER. (PG 3) 4521.26N 5474.79E -0.07N -0.21E FROM PLAN. PLAN INFO FROM THE PLAT SURVEY BY: MID AMERICA SURVEY COMPANY / GIVEN COORD. FROM MID AMERICA SURVEY.

2-27-92: SETUP ON POINT 5005N 5475E SITE WEST, AND SET POINT 5005N 5036. E. SET UP ON POINT 5005N 5036. E AND TIED INTO THE NW. CORNER OF PLAT SURVEY.

A ARCHED I.P. OUR COORD. > 5000.05N 5000.12E / GIVEN 5000 N 5000 E.

PT NO	NORTHING	EASTING	VERT DIST	HT ROD	ELEV	DESCRIPTION ②
1	5000.00	5475	—	—		⊼ SET-UP POINT A (property)
2	4521.33	5475	—	—		BACK SIGHT B (Property Line)
3	—	—				TBM =
4	6067.8	4862.9				CHECK NW COR BEACH HOUSE
5	6059.5	4809.5				CHECK SW " " "
6						Horiz Dist 495.0 (SET 1)
7	5975.2	4936.2				TEST TRENCH TT-1
8	5806.5	4874.6				" " TT-1
9	5923.9	4583.3				" " TT-2
10	5795.8	4712.1				" TT-2
11	5600.3	4918.1				SOIL BORING SB-1
12	5665.6	4727.5				" " SB-7
13						
14						
15						
16						
17						

PT NO	NORTHING	EASTING	D VERT	HT ROD	ELEV	H DIST	H. ∠	DESCRIPTION "			(3)
											2-25-92
18											
19											⊼ JHS [] JHS
20											∅ DNM
21	5000.05	5000.12	GIVEN CONTROL			(+0.05N, +0.12E)		(5000N, 5000E) NW CORNER	(FD PINCHED I.P.)		
22	4521.26	5474.79	"	"		(-0.07N, +0.21E) 499.49	1?? ?? ?1	(4521.33N, 5475E) NE CORNER	(FD NAIL)	(FG.1)	
23	4500	5600	SET CONTROL ON SITE					SET BRIDGE SPIKE		* BRIDGE SPIKE = LARGE	NAIL about 1' LONG
24	4900	5600	"	"	" "			" "			
25	4950	5600	"	"	" "			" "			
26	4300	"	"	"	" "			" "			
27	3950	"	"	"	" "			" "			
28	4000.26	5752.32	CHECK INTO OUR COORD POINT			(0.01N, -1.13E) 1016.23	???-22-??	NW	BLDING	COR.	GIVEN COORD. 4000.27N 5753.45E
29	4000.24	5841.17	GIVEN FROM PLAN	"	"	(-0.13N, -0.44E) 1033.30	16?-30-10	NE	BLDING	COR	4000.37N 5841.61E
30	4808.59	6059.95		"	"	(-0.93N, +0.42E) 500.13	113 07 25	SW	BEACH HSE. BLDING	COR.	4809.52N 6057.53E
31	4862.24	6067.65		"	"	(-0.68N, -0.14E) 488.90	106-58-32	NW	BEACH HSE, BLDING	COR.	4862.92N ~~6672.4E~~ 6067.79
32	3800	5600	SET CONTROL ON SITE					SET BRIDGE SPIKE			
33	3706	5600	"	"				" " "			
34	3600	5600	"	"(PK) *		IN CENTER OF PARKING LOT					

④

	NORTHING	EASTING	DESCRIPTION
			△③ POINT 4500N 5600E
			BACKSIGHT : NORTH
1.	4918.1	5600.3	SB-1 HUB - PINK RIBBON LATH
2	4920.5	5392.1	SB-2
3	4934.9	5206.2	SB 3
4	4737.9	5064.3	SB 4
5	4740.8	5266.9	SB 5
6	4736.3	5469.6	SB 6
7	4727.5	5665.6	SB 7
8	4528.1 ~~4498.4~~	5627.8	SB 8
9	4350.2	5503.6	SB 9
10	4175.1	5367.3	SB 10
11	4046.4	5233.3	SB 11
12	3835.0	4999.9	SB 12

(5)

	NORTHING	EASTING		H. DIST		DESCRIPTION
13	3840.3	5193.7			SB-13	HUB : PINK RIBBON LATH
14	3785.9	5390.1			SB-14	" " " "
15	3646.9	5270.9			SB-15	" " " "
16	3650.0	5075.1	(PK) ★ PAINTED ORANGE		SB-16	" " " "
17	3653.1	4865.8	(PK) ★ " " on a yellow parking line. hard to see. ~~4th stall from end.~~		SB-17	" " " "
18	4972.7	5036.1	★ SET UNDER ~~FRONT~~ MIDDLE OF BOAT (PAINTED HUB)		P-101	BLUE RIBBON LATH
19	4962.9	5958.4	MARK ON FENCE APPROX LOCATION 27' S SOUTH		P-102	" " "
19A	4005.2	5467.6			P-103	" " "
19B	4498.9	5574.1			P-104	" " "
20	4969.9	5530.0			MW-3D	BLUE RIBBON LATH
21	4968.8	5560.8			MW-3S	" " "
22	4139.5	5879.1			MW-4D	" " "
23	4109.4	5870.7			MW-4S	" " "
24	3842.4	4835.8			MW-5D	" " "
25	3872.5	4846.2			MW-5S	" " "

	NORTHING	EASTING			DESCRIPTION.			(6)
	4408.1	4924.5						
26	~~4412.66~~ 4408.1	~~5326.14~~ 4924.5			44 MW-6D: HUB		BLUE RIBBON	LATH
27	~~4418.09~~ ~~4441.0~~	~~5328.39~~ 4929.7			MW-6S	"	"	"
	4441.0	4929.7					GIVEN	COORD.
28	4418.09	5328.39			LOCATED	EASTING MW-1S	4416.11	~~4402.87~~ ~~5315.78~~
29	4412.66	5326.14			"	" MW-1D	4402.87 ~~5315.78~~	5309.92
30	4936.7	5975.65	4874.6	5806.5		TEST TRENCH -1	HUB: RED & YELLOW RIBBON	
31	4712.1	5795.8	4583.3	5923.9		2		
32	4520.9	5719.1	4347.3	5717.8		3		
33	4537.6	5553.8	4507.6	5519.2		4		
34	4516.4	5295.5	4441.1	5251.6		5		
35	4488.6	4962.8	4412.5	5036.8		6		
36	4272.5	5643.7	4218.9	5701.0		7		
37	4152.8	5613.0	4136.3	5697.8		8	X	
38	4201.1	5500.9	4133.9	5407.6		9		
39	4093.1	5648.9	4095.8	5683.3 ~~5649.3~~		10		

(7)

	NORTHING	EASTING				DESCRIPTION			
						~~CORNER OF @ "C" WALL~~			
						~~END OF FENCE @ PIER~~			
40	4453.5	4899.0			LOCATED	CORNER	FENCE	@ "C" WALL	
41	4474.9	5177.1				"	"		
42	4497.6	5175.2				"	"		
									2-27-92
43	4013.6	5647.3	3976.4	5646.6		TEST TRENCH -		11	
44	4019.9	5584.3	3996.3	5549.7				12	
45	4022.5	5492.5	4021.0	5443.5				13	
46	3957.0	5630.3	3915.4	5578.8				14	
47	3887.6	5638.5	NO HUB / LATH APPROX. ★ 3873.3	5567.5				15	
48	3952.32 ~~5411.7~~	5411.7 ~~3952.3~~	3919.7	5400.1				16	
49	3957.5	5387.9	3909.1	5333.7				17	
50	3768.8	5626.5	3765.1	5602.3				18	
51	3797.3 ~~39~~	5579.1	3732.4	5555.9				19	
52	3738.1	5601.0	3674.9	5585.8 (PK.) ★				20	
53	3726.3	5537.8	3682.1	5570.7				21	
54	3847.3	5344.8	3845.6	5284.1				22	

8

2-27-92

	NORTHING	EASTING			
55	3973.6	5562.2	3930.3	5548.6	TEST TRENCH - 23
					LOCATION OF TRAILERS ON SITE
	4194.4	5677.4			NW CORNER
	4194.3	5701.0			NE "
	4134.0	5676.7			SW "
	4167.2	5653.7			
	↓	↓			NE CORNER
	4167.1	5625.3			NW "
	4158.9	5625.4			SW "
	4150.5	5608.5			NW CORNER
	4138.6	5608.6			SW "
	4151.0	5654.8			NE "

(9)
2-27-92

NORTHING	EASTING				LOCATION OF TRAILERS				
4106.3	5655.0				SE	CORNER			
4106.1	5614.3				SW	"			
4116.4	5614.3				NW	"			
4107.4	5681.9				NW	CORNER			
4099.1	5681.7				SW	"			
4098.7	5697.8				SE	"			

3-5-9

OVERCAST 40° LITE RAIN

JMF

PAUL DICKENSON (WTD)

- Set 90° - 50' (S) Hubs FROM SB-23. W/ RIGHT angle glass
- Set one 100' (S) "Hub ON LINE W/ (S) 50' SOUTH
- Levels on all hubs TBM = SOUTH 50' (S)

11

	HI	BS	FS	ELEV	
TBM	103.54	3.54	~~103.54~~	100.0	SOUTH 50' ⊢ (S) HUB
SB-23			5.87	97.67	
HUB(TP)			4.48	99.06	N. 50' ⊢ (S) HUB
BS	103.89	4.83			
TBM			3.89	100.0	SAB
TBM-2			2.34	101.55	SOUTH 100' ⊢ (S) HUB ON FENCE

ERROR IN LOOP 0.00'

3/26/92

JMF, WWM/TWW

RUN LEVEL LOOP
OF WELLS & PIEZOMETERS
BM @ NORTH SIDE OF
LARSEN SLIP.
"X" in Larson ON
SEEWALL.
40° RAIN GREY
HAIL, SUNNY (5 min.),
Sleet, MORE RAIN.
HEAVY SNOW WITH
accumulation.

Well & PIEZ: P-101, MW-6S, MW-6D,
MW-1 NORTH, MW-1 SOUTH, P-104,
P-102, MW-3S, MW-3D,
P-103, MW-4S, MW-4D.

	HI	BS	FS	ELEV.	
BM	589.42	4.77		584.65	"X" ON SEAWALL @ LARSEN
TP			5.24	(584.18)	
BS	589.58	5.40			
TP			4.98	584.6	
BS	589.73	5.13			
TP			4.84	584.89	
BS	590.09	5.20			
P-101		5	5.1	(585.0) 584.99	GROUND
P-101			1.89	588.20	TOR = TP
BS	590.05	1.85			
TP			5.41	584.64	
BS	589.26	4.62			
TP			5.05	584.21	
BS	589.21	5.00			
BM			4.53	584.68	
LOOP ERROR =			0.03		

(14)

	HI	BS	FS	ELEV	
BM	589.89	5.24		584.65	"X" ON SEAWALL - @ CAISSON
MW-65			4.1	585.79	GROUND
MW-65			1.42	588.47	TOR
BS	590.13	1.66			SAA - Leg Kick
MW-60			4.4	585.73	Ground
MW-60			1.61	588.52	TOR
BM			5.49	584.64	"X" SAB
Loop Error =			0.01		
MW-65	589.97	1.50		588.47	TOR - TBM
MW-1			3.8	586.17	Ground } South well
MW-1			2.31	587.66 ✓	TOR
BS MW-1	590.46	2.80			SAA
MW-1			4.5	585.96 ✓	GROUND } North well
MW-1			2.67	587.79 ✓	TOR
BS	591.24	3.45			
P-104			5.2	586.04	Ground
P-104			2.13	589.11	TOR

(15)

	HI	BS	FS	ELEV	
BS	590.21	1.10			P-104 TOR
TP			5.24	584.97	RANDOM PT.
BS	590.95	5.98			
P-102			5.4	585.55	Ground
P102			2.39	588.56	TOR
BS	591.50	2.94			
MW-3S			6.3		Ground
MW-3S			3.21	588.29	TOR
BS	590.60	2.37			
MW-31			5.3		
MW-31			2.39	588.27	
BS	590.60	2.33			
TP			5.29	585.31	@ SB-6
BS	590.21	4.90			
TP			5.44	584.77	RANDOM PT.
BS	589.50	4.73			
TP.			5.04	584.46	
BS	590.09	5.63			

	HI	BS	FS	ELEV	
BM			5.47	584.62	"X" ON SEA WALL @ LARSEN 584.65
LOOP ERROR		.03			
BM	589.50	4.85		584.65	SAA
			4.98	584.52	H2O measurement POINT ↑ BARR (15' W of BM)
BM		4.85			

(H2O @ 4.49 Below PT)

~~3/26/92 2:30 pm~~

$$\begin{array}{r} 584.52 \\ 4.49 \\ \hline 580.03' \end{array}$$

= H2O ~~in new~~ slip.

(17)

	HI	BS	FS	ELEV
TBM	591.93	4.14		587.79
P-103			5.3	
P-103			2.45	589.48
BS	592.02	2.54		
TBM			4.21	587.78
Loop Error			= 0.01	
TBM	589.80	2.32		587.48
MW-4S			5.5	
MW-4S			2.57	587.23
BS	589.19	1.96		
MW-4D			5.1	
MW-4D			2.03	587.16
TBM			1.72	587.47
Loop Error			= 0.01	

MW-1 (NORTH)
GROUND
TOR
↓
SAA

TOR @ P-103
GROUND
TOR
↓
GROUND
TOR
SAA P-103 TOR.

18

3/27/92

JMF / TWW

Level Loop ON

wells & piezometers

including:

MW-5S, MW-5D

P-cloudy 30°

WINDY.

	HI	BS	FS	ELEV.		(19)
TBM	589.58	2.10		587.48	TOR P-103	
TP			6.54	583.04	RANDOM PT	
BS	587.57	4.53				
~~TP~~						
~~BS~~						
MW-5D			3.9		GROUND	
MW-5D			1.04	586.53	Riser	
BS-	587.83	1.30			LEG KICK	
MW-5S			4.5		Ground	
MW-5S			1.89	585.94	Riser	
BS	587.68	1.74			LEG KICK	
TP			4.65	583.03	RANDOM PT.	
BS	588.86	5.83				
TBM			1.36	587.50	TOR P-103	

LOOP ERROR = 0.02

RENTAL EQUIPMENT:

INSTRUMENT = TOPCON GTS 3C

HIEGHT PRISM: DOWN = 4.91
1 UP = 8.65
2 UP = 12.50

LEVEL = AT-F2

WAUKEGAN HARBOR TRUST

4-14-92

J Stalzer	Overcast
D. Mitchell	40°
10-15 mph

1) RAW LEVEL LOOP ON-SITE:
MW-3S, MW-3D, MW-6S, MW-6D,
MW-5S, MW-5D, P-102, P-104

4-14-92 THIS WILL INSTALL MSL ELEVATION
at a later date.

(21)

	+	HI	−	ELEV			
						LEVEL LOOP INTO ON SITE MW, 5'	4-14-92
						ELEVATION ON MW-3D RISER IS ON PAGE 41	
						ELEVATION = $\boxed{588.23}$	
	2.21	590.44			588.23	MW-3D 2" STEEL RISER	
			4.9	585.5		GRO.	
			2.21	588.23		CASING	
			5.2	585.2		GRO. MW-35 ~~STEEL 2"~~	
			2.13	588.31		CASING "	
TP1			2.20	588.24		RISER " (2" STEEL RISER)	
	3.345	591.59					
			6.0	585.6		GRO. P-102	
			3.02	588.57		CASING "	
TP2			3.07	588.52		RISER " (PVC 1¼" RISER)	
	2.44	590.96					
TP3			5.545	585.41	585.42	SPK @ STA. 4700N 5600E (PG 40)	
	5.65	591.06					

(22)

	+	HI	-	ELEV	LEVEL LOOP CONT.				4-14-92
		591.06							
			5.1	586.0	GRD.	P-101			
			1.96	589.10	CASING	"			
TP4			1.99	589.07	RISER	"	(1 1/4" PVC RISER)		
	1.93	591.00							
TP5			5.25	585.75	SPK @	STA.	4500N	5600E	
	6.23	591.98							
TP6			5.51	586.47	SPK @	STA.	3950N	5600E	(BENT)
	4.17	590.64							
TP7			2.15	588.49	NE COR.	OF 4'X	4' CONC.	SLAB	HOLDING
	0.98	589.47			FENCE.				
			3.8 ~~4.2~~	585.7	GRD.	MW-5D			
			~~1.56~~ 0.98	588.49	CASING	"			
TP8			1.00	588.47	RISER	"	(2" STEEL)		
	0.70	589.17							

LEVEL LO-OP - CONT.

4-14-92

	+	HI	−	ELEV			
		589.17					
			3.8	585.4	GRO	MW-5S	
			1.26	587.91	CASING	"	
TP9			1.28	587.89	RISER	"	(2" STEEL)
	2.13	590.02					
TP10			4.52	585.50	HARBOR WALK		
	6.125	591.63					
			5.9	585.7	GRO.	MW-6S	
			3.15	588.48	CASING	"	
TP11			3.18	588.45	RISER	"	(2" STEEL)
	2.49	590.94					
			5.2	585.7	GRO.	MW-6D	
			2.38	588.56	CASING	"	
TP12			2.43	588.51	RISER	"	(2" STEEL)
	2.63	591.14					

	+	HI	−	ELEV		LEVEL LOOP CONT..		4-14-92
		591.14						
			5.3	585.8		GRO.	MW-1D MOST SOUTHERLY	(EXISTING)
			3.40	587.74		CASING	"	
TP13			3.52	587.62		RISER	"	(2" STEEL)
	3.36	590.98						
			5.0	586.0		GRO	MW-1S MOST NORTHERLY OF 2	
			3.15	587.83		CASING	"	
TP14			3.22	587.76		RISER	"	(2" STEEL)
	4.07	591.83						
TP15			6.41	585.42	585.42	SPK @ STA 4+00N 5+00N		(TP 3)
	4.78	590.20						
TP16			1.965	588.23	588.23	RISER MW-3D ✓		

COKE PLANT RI/FS
WAUKEGAN ~~[illegible]~~

4-15-92
("TAX DAY"!!)

J. Staberg 50°
D. Mitchell OVERCAST
RAIN (ON & OFF)
5-10 MPH

1) Location of on site Test trenches, Borings, wells & Piezometer.

2) Location of off site Borings and wells. Also BMs.

X@ 4500N 5600E BS: NORTH T-R 4-15-92 (26)

	Nolh	EAST	COORDINATES Northing	Easting	Description		V.DIST	PRISM	ELEV
					ON-SITE LOCATIONS			HI=591.25	
1	0	0	4500	5600	TBM X@ 4500N 5600E		MEASURE UP 5.50	—	(PG.22) 585.75
2	200	0	4700	5600	BS TBM 4700N 5600E		—	4.90	(PG.24) 585.42
3	335.7	50.4	4836	5650	TT-00B		-1.5	"	584.9 ~~584.9~~
4	301	5.0	4801	5605	TT-00B		-1.5	"	584.9
5	420	-1.0 ~~1.0~~	4920.0	5599.0	SS-1		-1.0 ~~1.2~~	"	585.4
6	461.8	-48.0	4961.8	5552.0	MW-3D		-0.7	"	85.7
7	471.8	-46.7	4971.8	5553.3	MW-3S		2.8	UP 1 8.65	85.4
8	362.6	178.3	4863	5778	TT-1		-0.9	4.90	85.5
9	437.2	375	4937	5975	TT-1		-0.9	"	85.5
10	463.9	358.3 ~~463.4~~	4963.9	5958.3	P-102		-0.7	"	85.7
11	269	179	4769	5779	TT-00A		-1.3	"	85.1
12	243	186	4743	5786	TT-00A		-1.3	"	85.1
13	274	160.3	4774	5760	LATH WITH TAPE MARKED		-1.5	"	84.9
14	289	154	4654	5754	DANGER AREA		-1.3	"	85.1
15	297	140	4797	5740	"	"	-1.3	"	85.1
16	276	141	4796	5741	"	"	-1.2	"	85.2

	NRTH	EAST	NORTHING	EASTING	DESCRIPTION			Y.DIST	PRISM	ELEV.
						ON SITE	LOCATIONS			
17	226	189	4726	5789	TT-2			-1.6	4.90	84.8
18	88	317	4588	5917	TT-2			-1.8	"	84.6
19	-4.0	243	4496	5843	BARRELS (16) EX			-1.1	"	85.3
20	-18	244	4482	5844	"			-1.0	"	85.4
21	-20	238	4480	5838	"			-1.0	"	85.4
22	-3.0	233	4497	5833	"			-1.2	"	85.2
23	37	119	4537	5719	TT-3			-1.4	"	85.0
24	-153	118	4347	5718	TT-3			-1.0	"	85.4
25	-103	125	4397	5725	TT-03W			-1.1	"	85.3
26	-79	-97	4421	5503	TT-03W			0.1	"	86.5
27	-152	-95	43480	5505.0	SS-9			0.5	"	86.9
28	-0.1	-25.5	4499.9	5574.5	P-104			-0.2	"	86.2
29	7.4	-81	4507	5519	TT-4			0.3	"	86.7
30	43	-35	4543	5565	TT-4			-0.1	"	86.3
31	27	27.6	4527	5627.6	SS-8			-0.9	"	85.5
32	227.4	65.5	4727.4	5665.5	SS-7			-1.7	"	84.7

4-15-92 28

	NORTH	EAST	NORTHING	EASTING		DESCRIPTION			V. DIST	PRISM	ELEV
							ON-SITE LOCATIONS				
33	200	0	4700	5600	585.45	TBM/4700N	5600E	NAIL	-0.9'	4.90'	(PG. 24) 585.42
34	233.2	-70.3	4733.2	5529.7		SS-6			-0.6	"	85.8
35	-225	41	4275	5641		TT-7			-0.8	"	85.6
36	-281	101	4219	5701		TT-7			-1.2	"	85.2
37	-234	-115	4266	5485		TT-00C			0.6	"	87.0
38	-163	0	4337	5600		TT-00C			-0.1	"	86.3
39	-5.0	-316	4495	5284		TT-5			-1.1	"	85.3
40	-69	-369	4431	5231		TT-5			-0.8	"	85.6
41	-68.3	-679.7	4431.7	4920.3		MW-6S			-0.8	"	85.6
42	-57.9	-679.0	4442.1	4921.0		MW-6D			-0.6	"	85.8
43	-107	-637	4393	4963		TT-6	?		-1.2	"	85.2
44	-47	-638	4453	4962		TT-6	?		-1.0	"	85.4
45	-22	-326	4478	5274		TT-05E			-0.4	"	86.0
46	-93	-158	4407	5442		TT-05E	?		-0.5	"	85.9
47	-323.1	-237.0	4176.9	5363.0		SS-10			-0.6	"	85.8
4											

4-15-92 (29)

	NORTH	EAST	NORTHING	EASTING		DESCRIPTION		VDIST	PRISM	ELEV
						ON SITE LOCATIONS				
48	-478.0	-106.1	4022	5494	~~5550~~	TT-13		0.2	4.90	86.6
49	-464.0	-176	4036	5424		TT-13		-0.0	"	86.4
50	-495.1	-132.7	4004.9	5467.3		P-103		0.4	"	86.8
51	-570	-50	3930	5550		TT-23		-0.7	"	85.7
52	-524	-37	3976	5563		TT-23		-0.6	"	85.8
53	-518	-62	3982	5538		TT-12		-0.3	"	86.1
54	-482	-16	4018	5584		TT-12		0.1	"	86.5
55	-584	-21	3916	1684		TT-14		-0.7	"	85.7
56	-628	-35	3872	5565		TT-15		-0.5	"	85.9
57	-548	-188	3952	5412		TT-16		-0.2	"	86.2
58	-595	-202	3905	5398		TT-16		-0.8	"	85.6
59	-591	-266	3909	5334		TT-17		-0.6	"	85.8
60	-537	-208	3963	5392		TT-17		0.0	"	86.4
61	-653	-255	3847	5345		TT-22		-1.1	"	85.3
62	-655	-323	4177	5277		TT-22		-1.1	"	85.3

4-15-92 (30)

	NORTH	EAST	NORTHING	EASTING		DESCRIPTION		V. DIST.	PRISM	ELEV
						ON SITE LOCATIONS				
63	-609	-301	3891	5299		TT-22N		0.0	4.90	86.4
64	-662	-298	3838	5302		TT-22N		-0.8	"	85.6
65	-711.9	-210.1	3788.1	5389.9		SS-14		-1.5	"	84.9
66	-682	-179	3818	5421		TT-00D		-1.2	"	85.2
67	-792	-188	3708	5412		TT-00D		-1.5	"	84.9
68	-682	-179	3818	5421		TT-19W		-1.1	"	85.3
69	-723	-28	3777	5572		TT-19W		-0.4	"	86.0
70	-698	-19	3802	5581		TT-19		-0.2	"	86.2
71	-767	-43	3733	5557		TT-19		-0.1	"	86.3
72	-773	-62	3727	5538		TT-21		-0.9	"	85.5
73	-782	-53	3718	5547		TT-21	④ FOOTING (FOUNDATION)	0.1	"	86.5
74	-810	-35	3690	5565		TT-21	"	-0.2	"	86.2
75	-818	-29	3682	5571		TT-21		-1.1	"	85.3
76	-817	-12	3683	5588		TT-20		0.1	"	86.5
77	-800	~~-0.5~~ 0.0	3700	5600		SPIK 3700N	5600E	0.2	"	86.6
78	-761	5.0	3739	5605		TT-20		-0.1	"	86.3

	NRTH	EAST	NORTHING	EASTING	DESCRIPTION	V. DIST	PRISM	ELEV
					ON-SITE LOCATIONS			
79	-292	71	4208	5671	TT-10BA	-0.8	4.90	85.6
80	-298	24	4202	5624	TT-8A	-0.1	"	86.3
81	0.0	-315	4500	5285	SET CONTROL HUB 9	-0.9	"	85.5
					STA: 4500N 5285E			

X@ 3800N 5600E BS: NORTH T-R 4-15-92 (32)

	NORTH	EAST	NORTHING	EASTING		DESCRIPTION		Y.DIST	PRISM	ELEV
							Grade Locations		HI = 591.58	
1	7	—	3800	5600		X@ 3800N 5600E (SPK)		5.2	—	586.38
2	700	0	4500	5600		TBM / BS: 4500N 5600E (SPK)		2.82	*up 1 8.65	(PG.22) 585.75
3	403	-99	4203	5501			TT-9	0.5	4.90	87.2
4	334	-115	4134	5485			TT-9	0.1	"	86.8
5	214	48	4014	5648			TT-11	-0.4	"	86.3
6	163	43	3963	5643			TT-11	-0.3	"	86.4
7	101	92	3901	5692			TT-15	0.0	"	86.7
8	-31	26	3769	5626			TT-18	-0.2	"	86.5
9	-24	-29	3776	5571			TT-18	-0.7	"	86.0
10	163	34	3963	5634			TT-14	-0.2	"	86.5
11	40.3	-406.4	3840.3	5193.6			SS-13	-1.6	"	85.1
12	35.7	-598.8	3835.7	5001.2			SS-12	1.0	*4P1 8.65	83.9
13	2.6	-788.4	3802.6	4811.6			MW-5S	2.7	*4P1 8.65	85.6
14	7.9	-788.9	3807.9	4811.1			MW-5D	2.5	*4P1 8.65	85.4
15	247.1	-364.5	4047.1	5235.5			SS-11	-1.1	4.96	85.6
16	150	0	3950.0	5600.0	586.45	TBM	SPK@ 3950N 5600E	-0.23	"	(PG.22) 586.47

- LOCATION CONT.

4-15-94 (33)

	NORTH	EAST	NORTHING	EASTING	DESCRIPTION		V. DIST.	PRISM	ELEV
					OFF-SITE LOCATIONS				
#17	463.4	228.9	4263.4	5828.9	SC-02	(BIT. PARKING LOT.)	-0.9	4.90	85.8
#18	-200.6	0.9	3599.4	5600.9	SC-01	"	-2.3	"	84.4
#19	-153.0	-327.6	3647.0	5272.4	SS-15	(GRAVEL LOT)	-1.3	"	85.4
#20	-150.2	-524.6	3649.8	5075.4	SS-16	BIT. PARKING LOT	-1.5	"	85.2
#21	-146.9	-734.4	3653.1	4865.6	SS-17	"	6.0	up 2 12.50	85.1

×9 3950N 5600E BS: NORTH 7-R 4-15-92 (34)

OFF-SITE LOCATIONS

HI = 591.77

	NORTH	EAST	NORTHING	EASTING	DESCRIPTION		V.DIST.	PRISM	ELEV
1			3950	5600	TBM ×9	3950N 5600E	5.3	—	(PG. 22) 586.47
#2	168.3	274.1	4118.3	5874.1		MW-4D	-0.7	4.90	86.2
3	159.5	270.6	4109.5	5870.6		MW-4S	—	—	

⊼ Ⓢ 4500N 5285E BS: NORTH
T-R

(35)

	NORTH	EAST	NORTHING	EASTING	DESCRIPTION
					4-15-92
0			4500.0	5285.0	⊼ LARSON MARINE AREA
1	198.8	-88.7	4698.8	5196.3	TBM MARK IS THE TOP OF SHEET PILE ELEV MARKED "⊼" TBM ON SEAWALL 585.52
2	174.8	-346.4	4674.8	4938.6	BENCHMARK X ON SEAWALL
					NW CORNER SEAWALL ELEV MARKED 584.65
					20' ± WEST OF "SHED"
3	155.8	-317.1	4655.8	4967.9	NE COR "SHED"
4	147.6	-318.4	4647.6	4966.6	SE " "
5	216.1	-338.6	4716.1	4946.4	SE COR. STORAGE BLDING "LARSEN MARINE"
6	234.3	-437.2	4734.3	4847.8	SW " " " " "
7	176.6	-345.9	4676.6	4939.1	NW COR. SLIP (SHEET PILE)
8	103.4	-360.3	4603.4	4924.7	SW " " " "
9	106.2	-316.2	4606.2	4968.8	SE " " " "
10	161.3	-304.4	4661.3	4980.6	NE " " " "

⊼ ⊙ 505N, 5036E 1045 BS: ~~NORTH~~ EAST AZI: 90° T-R 4-15-92 (36)

$\boxed{HI=590.01}$

OFF-SITE LOCATIONS

	NORTH	EAST		
0	—	—	5005	5036
1	0.0	563.97	5005	5600
2	123.7	489.8	5128.7	5525.8
3	141.6	-80.38	5146.6	4955.6
4	-10.8	-0.0	4994.2	5036
5	0.0	1045.00	5005	6081

DESCRIPTION		VDIST	PRISM	ELEV
TBM/⊼ ⊙ 5005N, 5036E		5.35	—	(PG 41) 584.66
SPK ⊙ 5005N, 5600E		-0.32	4.91	84.8
	BS-07	7.32	4P2 12.50	84.8
	BS-06	1.21	4.91	86.[illegible]
	P-101	—	"	
SET SPK. 5005N, 6081E		1.62	"	586.72

OFF-SITE LOCATIONS

⊼ 5005N, 6081E BS: WEST AZM: 270° T.R

37

4.15.92

	NORTH	EAST	NORTING	EASTING	DESCRIPTION	V DIST	PRISM	ELEV
							HI = 592.07	
1	—	—	5005	6081	⊼ 5005N, 6081E	5.35	—	(PG.36) 586.72
2	0.0	-1045.00	5005	5036 ~~6081~~	TBM SPK 5005N, 5036E	-2.56	4.91	(PG.41) 584.66
[illegible]	439.6	117.8	5444.6	6198.8	BS#08	-1.6	"	85.6
4	-864.8	-203.3			BS ?	-1.2	"	

WAUKEGAN ~~HARBOR, EAST~~
COKE PLANT RI/FS

4-16-92

OVERCAST
RAINING/FOGGY
50°
5-10 mph

J. Staberg
D. Mitchell

BENCH MARK INFO:

BM USED "X" ON SEAWALL, NW CORNER OF SLIP.
at Larson Marine. 7' east of, &
41' SOUTH of; Larson Marine storage
blding, at slip. EL. GIVEN = 584.65
COORD: 4675N, 4939E

NOTE: THIS BM is used by Canonie
and Hi Tech. It was set by
Mid America Survey Co. 1-7-88.
Mid America Survey Co. came
off of a USGS BM. to establish
elevation. (FAX sheet from Mid America 4-16-92 JHS)

1) Levels into MW-4S, MW-4D, & P-103.

2) LEVELS INTO SITE LEVEL LOOP FROM USGS BM. THIS IS THE BM USED BY CANONIE.

TBM "^" on sheetpile marking TBM
EL. GIVEN = 585.52
COORD; 4699N, 5196E

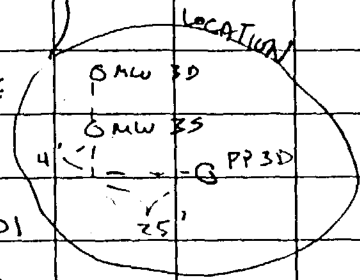
	+	HI	-	ELEV							
						LEVEL	LOOP	INTO P103, MW 4D, & MW 4S			4-16-92
					586.47	TBM	SPK @	3750N 5600E		(PG.22)	
	5.49	591.96									
			5.6	586.4			GRO	P.103			
			2.49	589.47			CASING	"			
TP1			2.52	589.44			RISER	"	(1¼" PVC)		
	2.44	591.88									
TP2			6.04	585.84							
	5.57	591.41									
			5.2	586.2			GRO	MW 4S			
			2.12	589.29			CASING	"			
TP3			2.24	589.17			RISER	"	(2" steel)		
	2.26	591.43									
			5.3	586.1			GRO	MW 4D			
			2.36	589.07			CASING	"			
TP4			2.37	589.06			RISER	"	(2" Steel)		
	2.79	591.85									
			5.43	586.45	586.47	TBM	SPK				

	+	HI	−	ELEV		LEVEL LOOP P.101, SS, 2,3,4 & 5, PP SD (40) 4-16-92
					584.62	X ON SEAWALL GIVEN EL = 584.62
	5.30	589.92				
TP1			5.43	584.49		Mark "BACK" ON SEAWALL (14' WEST OF X)
	5.60	590.09				
			5.3	584.8		SS-1
			5.5	584.6		SS-5
			4.8	585.3		SS-2 (2' WEST OF ORIGINAL)
TP2			4.58 ~~4.63~~	585.51		ON SEAWALL ~~585.52~~
	4.77	590.28				
TBM TP3			4.79	585.49	585.52	"Λ" MARK IN SEAWALL BM GIVEN EL = 585.52
	4.63	590.12				
			5.505	584.62	584.62	X ON SEAWALL ✓
TP4			5.05	585.07		ROCK
	5.27	590.34				
			4.8	585.5		SS-3
TP5			4.925	585.42		SP-4 4700N 5600E
	4.86	590.28				

(41)

4-16-92

	+	HI	-	ELEV		
		590.28	4.4	585.9		PP-3D 4975.8N, 5528.3E
TP6			2.045	588.23		RISER MW-3D
	1.56	589.79				
TP7			5.13	584.66		STK@ 5005N, 5036E
	5.445	590.11				
			5.1	585.0		GRD P-101
			1.90	588.21		CASING "
TP8			1.965	588.14		RISER "
	1.95	590.09				
TP9			5.27	584.82		
	5.28	590.10				
TBM11			5.49	584.61	584.62 ✓	X ON SEAWALL ✓



Appendix C

Soil Boring Logs

Potential Source Area
Investigation Shallow Borings

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/7/92
DATE COMPLETED: 3/7/92
FIELD INSPECTOR: S. Marshik (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SC-01
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 584.4

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		Blacktop 0.2'
							Crushed rock base material 1.2'
	1.5	FS	N	N	SSB		SILTY SAND TO SAND WITH SILT (SP-SM)- Fine grained, dark gray. (10YR 4/1) moist (Fill) 2.0'
							POORLY GRADED SAND (SP)- Fine grained, pale brown (10YR 6/3) wet below 2.9'. (Fill) 4.0'
5							E.O.B.
10							
15							
20							
25							
30							

COMMENT: **Oil Content In Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/7/92
DATE COMPLETED: 3/7/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SC-02
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 585.8

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		Blacktop 0.2' Crushed rock base material 1.2' SILTY SAND (SM)- With gravel, fine grained, black (5YR 5/1) moist (Fill).
	0	FS	N	N	SSB		2.0' SILTY SAND (SM)- With gravel, fine grained, very dark grayish-brown (10YR 3/2) moist wet below 3.4'. (Fill) 4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: Oil Content In Water: N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

Background Soil Borings

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/5/92
DATE COMPLETED: 3/5/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: BS-01
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: ~592

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		POORLY GRADED SAND WITH SILT (SP-SM)- Fine grained, dark brown (1.5 YR 3/2) (Fill)
							0.5'
	0	FS	N	N	SSB		POORLY GRADED SAND (SP)- Fine grained, light brown (7.5 YR 6/4) (Fill)
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/5/92
DATE COMPLETED: 3/5/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: BS-02
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: ~592

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		SANDY ORGANIC SOIL (OL/SM)-Fine grained, black (2.5Y 2/0)
							0.4'
							LEAN CLAY (CL)- Fine grained, dark grayish brown (2.5Y 4/2) moist (Fill)
							3.5'
	2	FS	N	N	G		POORLY GRADED SAND (SP)- Fine grained, light brown (7.5 YR 6/1) moist (Fill)
							4.0'
5							E.O.B.
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/5/92
DATE COMPLETED: 3/5/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: BS-03
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: ~589

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		POORLY GRADED SAND WITH TRACE OF SILT (SP TO SP/SM)-Fine grained, dark gray (5Y5/1), moist. Pieces of glass (Fill)
							2.0'
	2	FS	N	N	SSB		MIXED FILL: POORLY GRADED SAND WITH TRACE OF SILT (SP TO SP/SM)-Fine grained dark-gray (5Y 5/1), moist and ORGANIC SOIL (OL), Black (2.5Y 3/0), moist and LEAN CLAY WITH TRACE OF SILT (CL)-Pieces of glass and wood.
							4.0'
5							E.O.B.
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/5/92
DATE COMPLETED: 3/5/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: BS-04
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: ~588

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		POORLY GRADED SAND (SP)- Fine to medium grained, pale brown (10YR 6/3) with a trace of gravel (~2%), moist (Fill)
							2.8'
							Furnace glass, medium to fine sand size, black, moist.
							3.0'
	0	FS	N	N	SSB		POORLY GRADED SAND (SP)- Fine grained very pale brown (10 YR 7/3), moist (Fill).
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
BORING NO.: BS-05
DATE STARTED: 3/25/92
DATE COMPLETED: 3/25/92
RISER PIPE ELEVATION: --
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)
GROUND SURFACE ELEVATION: ~590

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		SANDY SLAG- Black (5YR 2.5/1) moist (Fill)
							1.4'
	1	FS	N	N	SSB		POORLY GRADED SAND (SP)- Fine grained, pale brown (10YR 6/3) moist, wet at 4.0' (Fill)
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: *G= Grab, SSB= Split - barrel with liner*
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/25/92
DATE COMPLETED: 3/25/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: BS-06
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 586.3

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		Sod
							0.2'
	O	FS	N	N	SSB		POORLY GRADED SAND (SP)- Fine to medium grained, pale brown.(10YR 6/3) moist (Fill)
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 **OF** 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/25/92
DATE COMPLETED: 3/25/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: BS-07
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 584.8

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		SOD 0.1'
							POORLY GRADED SAND (SP)- Fine to medium grained, pale brown (10YR 6/3) moist wet below 2'± (Fill)
	75	FS	N	N	SSB		
5							4.0' E.O.B.
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 **OF** 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/25/92
DATE COMPLETED: 3/25/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: BS-08
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 585.6

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		POORLY GRADED SAND (SP)- Fine to medium grained, pale brown.(10YR 6/3) moist wet below 3.5' (Alluvium)
	3	FS	N	N	SSB		
5							4.0' E.O.B.
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

Surficial Soil Borings

BORING LOG

PROJECT: WCP-RI/FS - Phase I
BORING NO.: SS-01
DATE STARTED: 3/10/92
DATE COMPLETED: 3/10/92
RISER PIPE ELEVATION: --
FIELD INSPECTOR: K. French (BEC)
CREW CHIEF: P. Dickinson (WTD)
GROUND SURFACE ELEVATION: 585.4

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	N	N	G		POORLY GRADED SAND TO POORLY GRADED SAND WITH SILT (SP TO SP-SM)- Fine to medium subrounded sand, less than 15% angular gravel, brown (10YR 5/3), to very dark grayish brown (10YR 3/2), moist, contains roots (Fill).
							1.5'
	4	FS	T	N	G & SSB		POORLY GRADED SAND WITH SILT (SP-SM)- Fine to medium sand, dark yellowish brown (10yr 4/6), moist to wet at approximately 3.0' (Fill).
							4.0'
5							E.O.B.
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/6/92
DATE COMPLETED: 3/6/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-02
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 585.3

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0							Crushed Rock Base Material
							0.4
	--	--	--	--	G		SILTY SAND (SM)- Fine grained, black (10YR 2/1) moist with some foundry slag clinkers (Fill)
							2.5'
	0.5	FS	N	N	SSB		POORLY GRADED SAND (SP)- Fine grained, pale brown (10YR 6/3), moist, wet below 3.0' (Fill)
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/6/92
DATE COMPLETED: 3/6/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-03

RISER PIPE ELEVATION: --

GROUND SURFACE ELEVATION: 585.5

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0							Crushed Rock Base Material 0.2'
	--	--	--	--	G		SILTY SAND (SM)- Fine grained, black (10YR 2/1) moist. (Fill) 2.5'
	42	FS	N	N	SSB		POORLY GRADED SAND (SP)- Fine grained, pale brown (10YR 6/3), moist (Fill)
5							4.0' E.O.B.
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/6/92
DATE COMPLETED: 3/6/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-04
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 584.8

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0							Crushed Rock Base Material
							0.2'
	--	--	--	--	G		SILTY SAND (SM)- Fine grained, black (10YR 2/1) moist, with some foundry slag clinkers (Fill)
							2.5'
	8	FS	N	N	SSB		POORLY GRADED SAND WITH SILT (SP-SM)- Fine grained, pale brown (10YR 6/3), moist, with some foundry slag clinkers (Fill)
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/6/92
DATE COMPLETED: 3/6/92
FIELD INSPECTOR: John Fox (B.E.C.)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-05
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 584.6

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0							Crushed rock base material. 0.2'
	--	--	--	--	G		POORLY GRADED SAND (SP-SM)-With a trace of gravel, fine to medium grained, dark gray (5Y4/1), moist (Fill) 2.0'
	150	FS	N	N	N		POORLY GRADED SAND (SP)- With trace of gravel, fine to medium grained, pale brown (10YR 6/3) moist (Fill) 4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/11/92
DATE COMPLETED: 3/11/92
FIELD INSPECTOR: K. French (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-06
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 585.8

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	N	G		SILTY SAND (SM)- Fine grained, black, oil present (Fill)
							2.5'
	11	FS	M	N	G,SSB		LEAN CLAY WITH SAND (CL-CS)-Dark brown (10YR 4/3) (Fill)
5							4.0' E.O.B.
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/10/92
DATE COMPLETED: 3/10/92
FIELD INSPECTOR: K. French (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-07
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 584.7

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		POORLY GRADED SAND WITH SILT (SP-SM)- Fine to medium subrounded sand with less than 15% subangular gravel, olive gray (5Y4/2), moist to wet at approximately 3.0', few roots to approximately 2.0' (Fill).
	O	FS	T	L	SSB		
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
BORING NO.: SS-08
DATE STARTED: 3/11/92
DATE COMPLETED: 3/11/92
RISER PIPE ELEVATION: --
FIELD INSPECTOR: S. Marshik (BEC)
CREW CHIEF: P. Dickinson (WTD)
GROUND SURFACE ELEVATION: 585.5

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		POORLY GRADED SILTY SAND (SP-SM)-Fine to medium grained, black, wet at 3.5' (Fill).
	2	FS	T	N	G,SSB		
4.0							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/11/92
DATE COMPLETED: 3/11/92
FIELD INSPECTOR: S. Marshik (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-09
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 586.9

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		SANDY LEAN CLAY (CL)- With trace of gravel, dark, yellowish, brown (10YR 4/4) (Fill)
							3.9'
	O	FS	N	N	G,SSB		POORLY GRADED SAND (SP)- Fine to medium grained, brown.(Fill)
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/11/92
DATE COMPLETED: 3/11/92
FIELD INSPECTOR: K. French (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-10

RISER PIPE ELEVATION: --

GROUND SURFACE ELEVATION: 585.8

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	N	G		POORLY GRADED SAND TO SAND WITH SILT (SP/SP-SM)- Fine grained, black (Fill)
							3.0'
	2	FS	T	N	G,SSB		SANDY LEAN CLAY (CL-CS)-With trace of gravel, dark yellowish brown (10YR 4/4) ~~(Fill)~~
							3.25'
							POORLY GRADED SAND (SP)- Fine to medium grained brown (10YR 5/3) (Fill)
							4.0'
5							E.O.B.
10							
15							
20							
25							
30							

COMMENT: Oil Content In Water: N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/11/92
DATE COMPLETED: 3/11/92
FIELD INSPECTOR: S. Marshik (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-11
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 585.6

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		POORLY GRADED SAND (SP)- Fine to medium grained, very dark grayish-brown (10YR 3/2) (Fill)
							2.5'
	0	FS	N	N	G,SSB		SANDY LEAN CLAY (CL-CS)-With trace of gravel, dark gray (10YR 4/1) (Fill)
							3.0'
							POORLY GRADED SAND (SP)- Fine grained, light yellowish-brown (10YR 6/4) (Fill)
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/11/92
DATE COMPLETED: 3/11/92
FIELD INSPECTOR: S. Marshik (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-12
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 583.9

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		POORLY GRADED SAND (SP)- Fine to medium grained, dark yellowish-brown (10YR 4/6). (Fill)
							2.5'
	O	FS	N	N	G,SSB		POORLY GRADED SAND (SP)- Fine to medium grained, light yellowish-brown (10YR 6/4). (Fill)
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/12/92
DATE COMPLETED: 3/12/92
FIELD INSPECTOR: S. Marshik (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-13
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 585.1

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	N	G		POORLY GRADED SAND TO SILTY SAND (SP-SM)-Fine to medium grained, black (Fill)
							0.5'
							POORLY GRADED SAND (SP)- Fine grained, pale brown (10YR 6/3) (Fill)
							2.5'
	6	FS	N	N	G,SSB		POORLY GRADED SAND (SP)- Fine grained, black, no odor.(Fill)
							2.6'
							POORLY GRADED SAND (SP)- Fine grained, pale brown (10YR 6/3). (Fill)
							4.0'
5							E.O.B.
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/12/92
DATE COMPLETED: 3/12/92
FIELD INSPECTOR: S. Marshik (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-14
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 585.2

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		COAL FINES, BLACK.
					G		3.5'
	6	FS	T	N	SSB		POORLY GRADED SAND (SP)- Fine to medium grained, grayish-brown (10YR 5/2) (Fill)
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 **OF** 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/7/92
DATE COMPLETED: 3/7/92
FIELD INSPECTOR: S. Marshik (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-15
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 585.4

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		Gravel base material
							0.1'
							SILTY SAND (SM)-With gravel, fine grained, black (5YR 5/1), moist (Fill)
							1.0'
	O	FS	N	N	N		POORLY GRADED SAND (SP)- Trace gravel ,fine grained, light yellowish brown (10YR 6/4) moist (Fill)
							4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: *L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel*
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/7/92
DATE COMPLETED: 3/7/92
FIELD INSPECTOR: S. Marshik (B.E.C.)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-16

RISER PIPE ELEVATION: --

GROUND SURFACE ELEVATION: 585.2

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	T	N	G		Blacktop 0.2
							Crushed rock base material 1.0'
	0.5	FS	N	N	SSB		SILTY SAND (SP-SM)- With gravel, fine grained, black (5YR 5/1), moist, with foundry slag. (Fill)
5							4.0' E.O.B.
10							
15							
20							
25							
30							

COMMENT: **Oil Content In Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/7/92
DATE COMPLETED: 3/7/92
FIELD INSPECTOR: S. Marshik (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SS-17
RISER PIPE ELEVATION: --
GROUND SURFACE ELEVATION: 585.1

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	T	N	G		Blacktop 0.1' Crushed rock base material 1.0'
	1	FS	N	N	SSB		SILTY SAND (SM)- With a trace of gravel, black (5YR 5/1), moist (Fill) 2.0' POORLY GRADED SAND (SP)- Fine grained light, brownish gray (10YR 6/2) moist (Fill) 4.0' E.O.B.
5							
10							
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Borehole backfilled with cuttings.

SHEET 1 OF 1

Pilot Borings

BORING LOG

PROJECT: WCP-RI/FS - Phase I
BORING NO.: SB-03
DATE STARTED: 3/16/92
DATE COMPLETED: 3/18/92
RISER PIPE ELEVATION: --
FIELD INSPECTOR: T. Wright-Wells (BEC)
CREW CHIEF: P. Dickinson(WTD)
GROUND SURFACE ELEVATION: 585.9

Depth (Feet)	OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	0	--	N	N	SSB		SILTY SAND (SM)- Medium grained, brown to dark brown sand, with gravel from 0.5 to 1.0' (Fill).
							1.5'
							Coal fines, fine to 1" pieces.
							2.5'
	2.4	--	N	N	SSB		POORLY GRADED SAND (SP)- Medium grained, brown, with a clayey sand lense from 5.0-5.3', moist to wet (Fill)
							5.0'
5	6.2	--	N	N	SSB		POORLY GRADED SAND (SP)- Medium grained, gray (10YR 6/1) with trace rounded pebbles, wet (Alluvium)
	30	--	N	N	SSB		
							8.0'
	90	--	N	N	SSB		SAND WITH SILT (SP-SM)- Fine grained, dark gray (10YR 4/1), with trace rounded pebbles, wet (Alluvium).
10	34	--	N	N	SSB		
							11.0'
	8	--	N	N	SSB		SILTY SAND (SM)- Fine to medium grained, dark gray (10YR 4/1) with black mottling throughout, wet (Alluvium)
15	6	--	N	N	SSB		
	160	--	N	L	SSB		
	760	--	N	M	SSB		
20							20.0'
	>1000	--	N	M	SSB		SAND WITH SILT (SP-SM)- Fine to medium grained, gray (10YR 5/1) with a trace black mottling throughout, wet (Alluvium).
	>1000	--	N	M	SSB		
25	>1000	--	N	M	SSB		
	>1000*	--	N	L	SSB		160 ppm nonmethane OVA reading (see Boring Log MW-3D)
							28.5'
	>1000	--	N	M	SSB		SILT WITH CLAY (ML-CL)- Gray (10YR5/1), very dense, low to medium toughness, low to medium plasticity with angular gravel from 28.5-29' moist (Till).
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 6 1/4" I.D. hollow stem auger to 6 feet below grade. Boring was completed using mud rotary. Borehole backfilled with tremied neat cement grout.
* See Boring Log MW-3D for nonmethane OVA reading for this interval

BORING LOG

PROJECT: WCP-RI/FS - Phase I
BORING NO.: SB-03
DATE STARTED: 3/16/92
DATE COMPLETED: 3/18/92
RISER PIPE ELEVATION: --
FIELD INSPECTOR: T. Wright-Wells (BEC)
CREW CHIEF: P. Dickinson (WTD)
GROUND SURFACE ELEVATION: 585.9

Depth (Feet)	OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
30	28	--	N	N	SSB		SILT WITH CLAY (ML-CL)-Gray (10YR5/1), very dense, low to medium toughness, low to medium plasticity, moist (Till).
	62	--	N	N	SSB		
35	5.7	--	N	N	SSB		
40	0	--	N	N	SSB		
45	>1000	--	N	N	SSB		
50							Boulder, gray dolomite.
55	40	--	N	N	SSB		
60							60.0'

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 6 1/4" I.D. hollow stem auger to 6 feet below grade. Boring was completed using mud rotary. Borehole backfilled with tremied neat cement grout.

SHEET 2 OF 4

BORING LOG

PROJECT: WCP-RI/FS - Phase I
BORING NO.: SB-03
DATE STARTED: 3/16/92
DATE COMPLETED: 3/18/92
RISER PIPE ELEVATION: --
FIELD INSPECTOR: T. Wright-Wells (BEC)
CREW CHIEF: P. Dickinson (WTD)
GROUND SURFACE ELEVATION: 585.9

Depth (Feet)	OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
60							
65	90	--	N	N	SSB		CLAYEY SILT (CL-ML)- Gray (10YR 4/1), soft to firm, with cobbles at 81-83', 87-89', 92.5 - 93.5' and from 103' to E.O.B; thin sand lenses from 85-85.3' and from 94-94.5', moist. (Till)
70							
75	10	--	N	N	SSB		
80							
85	8	--	N	N	SSB		
90							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 6 1/4" I.D. hollow stem auger to 6 feet below grade. Boring was completed using mud rotary. Borehole backfilled with tremied neat cement grout.

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/16/92
DATE COMPLETED: 3/18/92
FIELD INSPECTOR: T. Wright-Wells (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SB-03

RISER PIPE ELEVATION: --

GROUND SURFACE ELEVATION: 585.9

Depth (Feet)	OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
90							CLAYEY SILT (CL-ML)-Gray (10YR4/1), soft to firm, with cobbles at 92.5- 93.5' and from 103' to E.O.B.; thin sand lenses from 94-94.5', moist (Till).
95	54	--	N	N	SSB		
100							
105	6	--	N	N	SSB		
							108.0'
							Dolomite bedrock- gray. Logged from chips.
							109' E.O.B.
110							
115							
120							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 6 1/4" I.D. hollow stem auger to 6 feet below grade. Boring was completed using mud rotary. Borehole backfilled with tremied neat cement grout.

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/18/92
DATE COMPLETED: 3/18/92
FIELD INSPECTOR: T. Wright-Wells (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: MW-3D
RISER PIPE ELEVATION: 588.23
GROUND SURFACE ELEVATION: 585.5

Depth (Feet)	OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0							See Boring Log SB-03
5							
10							
15							
20							
25							
	160	P, Ph,V	N	L	SSB		
							28.0' E.O.B.
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 6 1/4" I.D. hollow stem auger. Monitoring well MW-3D installed in borehole.

SHEET 1 **OF** 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
BORING NO.: SB-04
DATE STARTED: 3/20/92
DATE COMPLETED: 3/20/92
RISER PIPE ELEVATION: 589.06
FIELD INSPECTOR: T. Wright - Wells (BEC)
CREW CHIEF: P. Dickinson (WTD)
GROUND SURFACE ELEVATION: 586.1

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	2	--	N	N	SSB		SILTY SAND (SM)- Fine to medium grained, brown (Fill). 0.5'
							Coal fines with limestone gravel. 1.0'
	2	--	N	N	SSB		POORLY GRADED SAND (SP)- Fine to medium grained brown. (Fill) 5.0'
5	10	--	N	N	SSB		POORLY GRADED SAND (SP)- Medium grained, gray w/black mottling (10YR 5/1). (Alluvium)
	0	--	N	N	SSB		
10	26	--	N	N	SSB		
	75	--	N	N	SSB		
15	21	--	N	N	SSB		
	24	--	N	N	SSB		
20	7	--	N	N	SSB		
	250	--	N	N	SSB		
25	1000	--	N	M	SSB		
	500	--	N	M	SSB		
30							

COMMENT: **Oil Content In Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 6 1/4" I.D. hollow stem auger. Monitoring well MW-4D installed in borehole.

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/20/92
DATE COMPLETED: 3/20/92
FIELD INSPECTOR: T. Wright-Wells (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: SB-04
RISER PIPE ELEVATION: 589.06
GROUND SURFACE ELEVATION: 586.1

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
30							31.0'
	1250	P,Ph,V	N	M	SSB		POORLY GRADED GRAVEL (GP)- Medium to coarse grained, grey, wet (Alluvium)
							31.5'
							SILT TO SILT WITH CLAY (ML/ML-CL)-Light gray (10YR 7/1) trace coarse sand, moist (Till)
							32.0' E.O.B.
35							
40							
45							
50							
55							
60							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 6 1/4" I.D. hollow stem auger. Monitoring well MW-4D installed in borehole.

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/23/92
DATE COMPLETED: 3/23/92
FIELD INSPECTOR: J. Fox (BEC)
CREW CHIEF: B. Loveland (WTD)

BORING NO.: SB-05
RISER PIPE ELEVATION: 588.47
GROUND SURFACE ELEVATION: 585.7

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	0	--	N	N	G		POORLY GRADED SAND (SP)- Fine grained w/a trace of gravel, light brownish grey (10YR 6/2) (Fill) — 5.0'
5	20	--	N	N	SSB		POORLY GRADED SAND (SP)-Fine grained, grey (10YR 6/1), wet (Alluvium) — 7.0'
	5	--	N	N	SSB		POORLY GRADED SAND WITH GRAVEL (SP)-Fine to medium grained, grey (10yr 6/1), wet (Alluvium)
10	15	--	N	N	SSB		12.0'
	9	--	N	N	SSB		POORLY GRADED SAND (SP/SP-SM) -W/a trace of silt, fine grained, grey (10yr 5/1) slightly stained or mottled dark grey (10YR 4/1), wet (Alluvium)
15	30	--	N	N	SSB		
	12	--	N	N	SSB		
20	50	--	N	N	SSB		22.0'
	80	--	N	N	SSB		POORLY GRADED SAND (SP)- Fine to medium grained, dark grey (10YR 4/1), wet (Alluvium) — 25.5'
25	75	P,Ph,V	N	N	SSB		POORLY GRADED GRAVEL (GP)- Medium to coarse grained, grey (10YR 6/1) wet (Alluvium) — 25.7'
							SILT (ML/ML-CL)-With a trace of clay and a trace of coarse sand (<1%), light grey (10YR 7/1) moist (Till). — 27.0'
30							E.O.B.

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 6 1/4" I.D. hollow stem auger. Monitoring Well MW-5D installed in borehole.

BORING LOG

PROJECT: WCP-RI/FS - Phase I
BORING NO.: SB-06
DATE STARTED: 3/24/92
DATE COMPLETED: 3/24/92
RISER PIPE ELEVATION: 588.51
FIELD INSPECTOR: T. Wright-Wells (BEC)
CREW CHIEF: B. Loveland (WTD)
GROUND SURFACE ELEVATION: 585.7

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	--	--	G		POORLY GRADED SAND (SP)- Fine to medium grained, brown (10YR 5/3), with 3" of dark gray sand at 2.5' (Fill)
	0	--	N	N	SSB		
5	3	--	N	N	SSB		7.5'
	4	--	N	N	SSB		POORLY GRADED SAND (SP)- Light gray (10YR 6/1) fine to medium grained. (Alluvium)
10							10.0'
	0	--	N	L	SSB		POORLY GRADED SAND (SP)- Dark gray (10YR 4/1) With black mottling.(Alluvium)
	50	--	N	L	SSB		
15	10	--	N	L	SSB		
	75	--	N	L	SSB		
20	250	--	N	L	SSB		
	150	P, Ph,V	N	M	SSB		Unable to collect analyticals due to lack of sample.
25	200	--	N	L	SSB		26.2' POORLY GRADED GRAVEL (GP) 26.5' SILT (ML)- Light gray (10YR 7/1) (Till) 27.5' E.O.B.
30							

COMMENT: **Oil Content In Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 6 1/4" I.D. hollow stem auger. Monitoring well MW-6D installed in borehole.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/9/92
DATE COMPLETED: 3/9/92
FIELD INSPECTOR: K. French (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: P-101
RISER PIPE ELEVATION: 588.14
GROUND SURFACE ELEVATION: 585.0

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0							Gravel-Crushed Rock
							0.2'
							SILTY SAND (SM)- Fine to medium sand, black (Fill)
							1.0'
						▽ 2.8'	POORLY GRADED SAND (SP)- Fine to medium rounded sand, less than 10% silt, up to 10% fine gravel, very dark grayish brown (10YR 3/2) to dark grayish brown (10yr 4/2), moist to wet (Alluvium).
5	--	--	N	N	G		
10	--	--	N	N	G		
							14.0' E.O.B.
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Piezometer P-101 installed in borehole.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/12/92
DATE COMPLETED: 3/12/92
FIELD INSPECTOR: K. French (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: P-102
RISER PIPE ELEVATION: 588.52
GROUND SURFACE ELEVATION: 585.6

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	N	N	G		POORLY GRADED SAND (SP)- Medium to coarse subrounded sand, less than 5% silt, very dark gray (7.5 YR3/0) discolored, moist, contains roots (Fill)
							2.0'
						2.6'	POORLY GRADED SAND (SP)- Fine to medium subrounded to rounded sand, less than 10% silt, black (7.5 YR 2/0), discolored, wet to saturated (Alluvium)
5	--	--	N	N	G		
10							
	--	--	T	L	G		
							14.0' E.O.B.
15							
20							
25							
30							

COMMENT: **Oil Content In Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Piezometer P-102 installed in borehole.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
BORING NO.: P-103
DATE STARTED: 3/12/92
DATE COMPLETED: 3/13/92
RISER PIPE ELEVATION: 589.44
FIELD INSPECTOR: K. French (BEC)
CREW CHIEF: P. Dickinson (WTD)
GROUND SURFACE ELEVATION: 586.4

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	N	N	G		POORLY GRADED SAND WITH SILT (SP-SM)- Fine to medium subrounded sand, less than 15% gravel, very dark gray (10YR 3/1), moist, contains roots (Fill)
							1.0'
							POORLY GRADED SAND (SP)- Fine to medium rounded sand, less than 5% silt, dark grayish brown (2.5YR 4/2) to dark gray (10YR 4/1) at 6.0', moist to wet (Alluvium)
5	--	--	N	N	G	▽ 5.4	
	--	--	N	N	G		
10							
	--	--	N	N	G		
							14.5'
15							E.O.B.
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Piezometer P-103 installed in borehole.

SHEET 1 OF 1

BORING LOG

PROJECT: WCP-RI/FS - Phase I
DATE STARTED: 3/12/92
DATE COMPLETED: 3/12/92
FIELD INSPECTOR: K. French (BEC)
CREW CHIEF: P. Dickinson (WTD)

BORING NO.: P-104
RISER PIPE ELEVATION: 589.07
GROUND SURFACE ELEVATION: 586.0

Depth (Feet)	Nonmethane OVA Headspace (ppm)	Analytical Sample Type	Oil Content in Water	Product Odor	Sampling Method	Profile	DESCRIPTION OF MATERIALS AND REMARKS
0	--	--	T	N	G		POORLY GRADED SAND (SP)- Medium subrounded sand 5-10% silt, black (5Y2.5/1), moist (Fill)
							2.5'
						3.6'	
5	--	--	M	L	G		POORLY GRADED SAND (SP)- Fine to medium subrounded to rounded sand, less than 5% silt, black (5Y2.5/1) to very dark gray (7.5 YR 3/0), wet to saturated (Alluvium).
	--	--	T	L	G		
10							
	--	--	T	N	G		
							14.0' E.O.B.
15							
20							
25							
30							

COMMENT: **Oil Content in Water:** N = None, T = Trace, M = Moderate, H = Heavy
Odor: L= Low, M = Moderate, S = Strong, V = Very Strong, P= Petroleum, D= Diesel
Sampling Method: G= Grab, SSB= Split - barrel with liner
Analytical Sample Type: V = VOC's, P=PAHs, M= metals, Ph = Phenol, Pc = PCBs, Pe = Pesticides, A = Arsenic, C= Cyanide, T=TCLP, FS = Full Scan Analyses (V,P,M,Ph,Pc,Pe,C).
Borehole drilled using 3 1/4" I.D. hollow stem auger. Piezometer P-104 installed in borehole.

SHEET 1 OF 1

Appendix D
left out intentionally
because of size

Appendix E

Monitoring Well and Piezometer Construction Logs

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

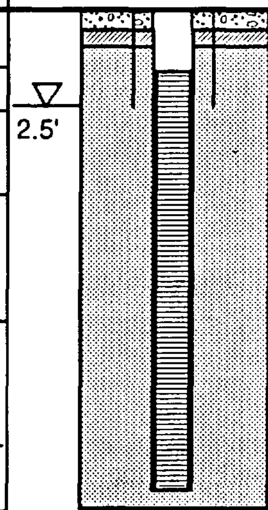
Project WCP RI/FS Phase I Well No. MW-3S

Date Started 3/13/92

Date Completed 3/14/92 Riser Pipe Elevation 588.24[1]

Field Inspector K. French (BEC)

Crew Chief P. Dickinson (WTD) Ground Surface Elevation 585.2

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Borehole advanced from 0' to 13.0' (585.2-572.2) using 6 1/4-inch I.D. hollow stem auger. Inside of auger flushed with potable water Well screen and riser pipe placed in the borehole. Sand pack and then bentonite pellets placed as auger retracted. Neat cement grout to surface. Water level was 2.5' below surface, on 3-13-92.	Fill 1.5' Coal Fines 2.5' Sand Fill 5.0' Medium Sand 8.0' Sand With Silt 11.0' Silty Sand 13.0' E.O.B.		Stickup:3.04' 2 -inch diameter, stainless steel riser pipe 0' to 1.5' (585.2-583.7). 2-inch diameter, 10.5' long, #10 slot size stainless steel screen 1.5' - 12.0' (583.7-572.2). Sandpack 1.0 - 13.0' (584.2 - 572.2). Bentonite seal 0.5' - 1.0' (584.7 - 584.2). Cement grout 0 - 0.5'. 4-foot long steel protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

Sheet 1 of 1

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

Project WCP RI/FS Phase I

Well No. MW-3D

Date Started 3/18/92

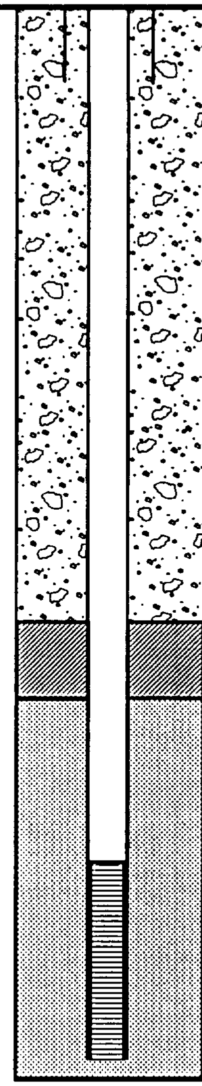
Date Completed 3/18/92

Riser Pipe Elevation 588.23[1]

Field Inspector T. Wright-Wells (BEC)

Crew Chief P. Dickinson(WTD)

Ground Surface Elevation 585.5

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Borehole advanced from 0' to 28.0' (585.5 - 557.5) using 6 1/4-inch I.D. hollow stem auger. Inside of auger flushed with potable water. Well screen and riser pipe placed in borehole. Sand pack and then bentonite pellets placed as auger retracted. Neat cement grout to surface.	Silty Sand Fill 1.5' Coal Fines 2.5' Medium Sand Fill 5.0' Clayey Sand 5.3' Medium Sand 8.0' Fine Sand With Silt 11.0' Silty Sand 20.0' Fine Sand With Silt 28.0' E.O.B.		Stickup up:2.73' 2-inch diameter, stainless steel riser pipe 0' to 22.8' (585.5-562.7). 2-inch diameter, 5' long , #10 slot size stainless steel screen 22.8'-27.8' (562.7-557.7') Sandpack 18'-27.8' (567.5-557.7). Bentonite seal 16.0-18.0' (569.5 - 567.5) Cement grout 0 - 16.0' (585.5 - 569.5) 5-foot long protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

Sheet 1 of 1

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

Project WCP RI/FS Phase I

Well No. MW-4S

Date Started 3/19/92

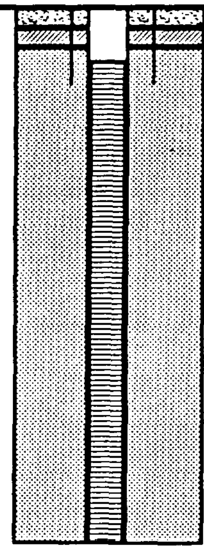
Date Completed 3/19/92

Riser Pipe Elevation 589.17'[1]

Field Inspector S. Marshik (BEC)

Crew Chief P. Dickinson(WTD)

Ground Surface Elevation 586.2

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Borehole advanced from 0' to 14.0' (586.2 - 572.2) using 6 1/4-inch I.D. hollow stem auger. Inside of auger flushed with potable water. Well screen and riser pipe placed in borehole. Sand pack and then bentonite pellets placed as auger retracted. Neat cement grout to surface.	Topsoil Silty Sand Fill and Coal Fines 1.0' Fine to Medium Sand Fill 5.0' Medium Sand 14.0' E.O.B.		Stickup up:2.97' 2-inch diameter, stainless steel riser pipe 0' to 1.7' (586.2- 584.5). 2-inch diameter 10.3' long , #10 slot size 1.7-12.0 (584.5-574.2) Sandpack 1.0- 14.0' (585.2 - 572.2) Bentonite seal 0.5-1.0' (585.7 - 585.2) Cement grout 0 - 0.5' (586.2 - 585.7') 5-foot long protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

Sheet 1 of 1

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

Project WCP RI/FS Phase I

Well No. MW-4D

Date Started 3/20/92

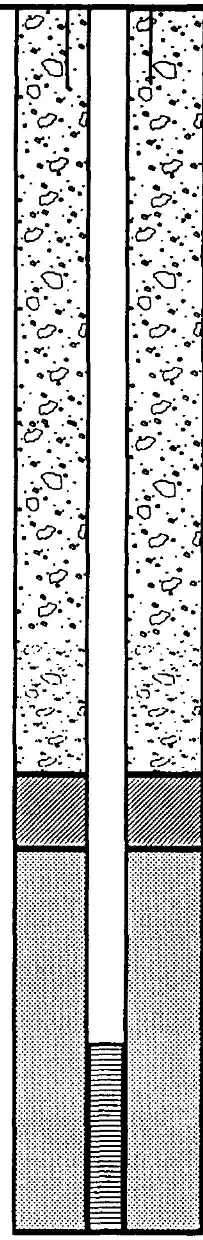
Date Completed 3/20/92

Riser Pipe Elevation 589.06[1]

Field Inspector T. Wright-Wells (BEC)

Crew Chief P. Dickinson(WTD)

Ground Surface Elevation 586.1

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Borehole advanced from 0' to 32.0' (586.1-554.1) using 6 1/4-inch I.D. hollow stem auger. Inside of auger flushed potable water. Well screen and riser pipe placed in the borehole. Sand pack and then bentonite pellets placed as auger retracted. Neat cement grout to surface.	Silty SandFill 0.5' Coal Fines 1.0' Fine to Medium Sand Fill 5.0' Medium Sand 31.0' Gravel 31.5' Silt 32.0' E.O.B.		Stickup: 2.96' 2 -inch diameter, stainless steel riser pipe 0' to 27.0' (586.1-559.1). 2-inch diameter, 5' long, # 10 slot size stainless steel screen, 27.0-32.0' (559.1 - 554.1) Sandpack 22.0'-32.0' (564.1 - 554.1) Bentonite seal 20.0-22.0' (566.1- 564.1) Cement grout 0 - 20.0' (586.1 - 566.1) 5-foot long steel protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

Sheet 1 of 1

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

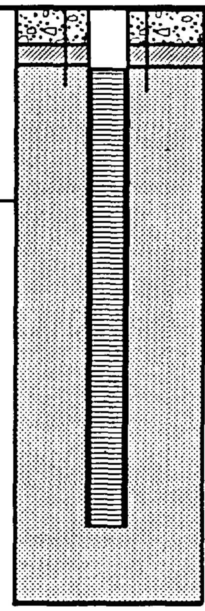
Project WCP RI/FS Phase I — Well No. MW-5S

Date Started 3/20/92

Date Completed 3/20/92 — Riser Pipe Elevation 587.89[1]

Field Inspector S. Marshik (BEC)

Crew Chief B. Loveland(WTD) — Ground Surface Elevation 585.4

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Borehole advanced from 0' to 15.0' (585.4-570.4) using 6 1/4-inch I.D. hollow stem auger. Inside of auger flushed with potable water. Well screen and riser pipe placed in the borehole. Sand pack and then bentonite pellets placed as auger retrated. Neat cement grout to surface. Water level was 4.8' below surface on 3-20-92.	Fine Sand Fill 5.0' Fine Sand 7.0' Fine to Medium Sand with Gravel 12.0' Fine Sand with Trace Silt 15.0' E.O.B.	4.8' 	Stickup:2.49' 2 -inch diameter, stainless steel riser pipe 0' to 2.8' (585.4-582.6). 2-inch diameter, 10.4' long #10 slot size stainless steel screen 2.8' - 13.2' (582.6-572.2). Sandpack 1.8' to 15.0' (583.6 - 570.4). Bentonite seal 1.0' - 1.8' (584.4 - 583.6). Cement grout 0 - 1.0'. 5-foot long steel protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

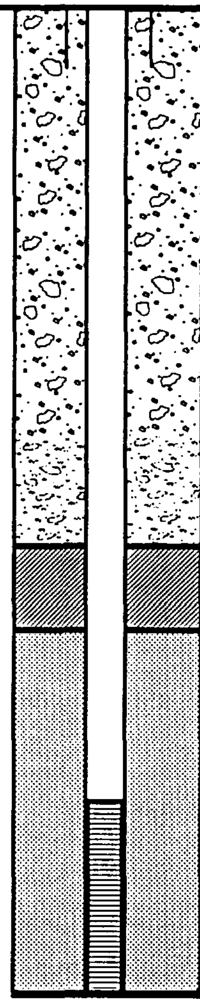
Project WCP RI/FS Phase I — Well No. MW-5D

Date Started 3/23/92

Date Completed 3/23/92 — Riser Pipe Elevation 588.47[1]

Field Inspector J. Fox (BEC)

Crew Chief B. Loveland(WTD) — Ground Surface Elevation 585.7

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Borehole advanced from 0' to 26.0' (585.4-559.7) using 6 1/4-inch I.D. hollow stem auger. Inside of auger flushed with potable water. Well screen and riser pipe placed in borehole. Sand pack and then bentonite pellets placed as auger retracted. Neat cement grout to surface.	Fine Sand Fill 5.0' Fine Sand 7.0' Fine to Medium Sand with Gravel 12.0' Fine Sand with a Trace of Silt 22.0' Fine to Medium Sand 25.5' Gravel 25.7' Silt 26.0' E.O.B.		Stickup:2.77' 2-inch diameter, stainless steel riser pipe 0' to 14.0' (585.7-571.7). 2-inch diameter, 5' long, #10 slot size stainless steel screen, flush threaded 21.0'-26.0' (564.7 - 559.7) Sandpack 16.0' - 26.0' (569.7' - 559.7). Bentonite seal 14.0' - 16.0' (571.7' -569.7') Cement grout 0 - 14.0' (585.7' - 571.7') 5-foot long steel protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

Sheet 1 of 1

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

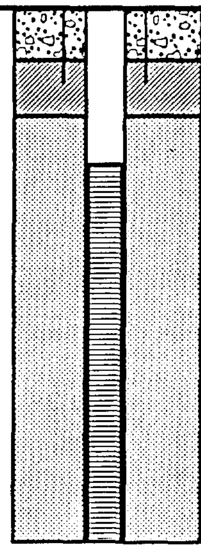
Project WCP RI/FS Phase I — Well No. MW-6S

Date Started 3/25/92

Date Completed 3/25/92 — Riser Pipe Elevation 588.45[1]

Field Inspector T. Wright-Wells (BEC)

Crew Chief P. Dickinson(WTD) — Ground Surface Elevation 585.7

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Borehole advanced from 0' to 13.5' (585.7 - 572.2) using 6 1/4-inch I.D. hollow stem auger. Inside of auger flushed potable water. Well screen and riser pipe placed in borehole. Sand pack and then bentonite pellets placed as auger retracted. Neat cement grout to surface.	Fine to Medium Sand Fill 7.5' Fine to Medium Sand 14.0' E.O.B.		Stickup: 2.75 2 -inch diameter, stainless steel riser pipe 0' to 3.5' (585.7 - 582.2). 2-inch diameter, 10' long, #10 slot size stainless steel screen 3.5-13.5' (582.2-572.2) Sandpack 2.5 - 13.5' (583.2 - 572.2) Bentonite seal 1.0-2.5' (584.7 - 583.2) Cement grout 0 - 1.0' (585.7 - 584.7) 5- foot long protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

Sheet 1 of 1

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

Project WCP RI/FS Phase I

Well No. MW-6D

Date Started 3/24/92

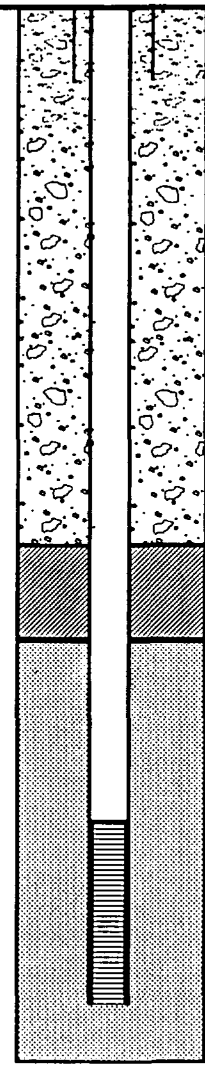
Date Completed 3/24/92

Riser Pipe Elevation 588.51[1]

Field Inspector T. Wright-Wells (BEC)

Crew Chief B. Loveland (WTD)

Ground Surface Elevation 585.7

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Borehole advanced from 0' to 27.5' (585.7 - 558.2) using 6 1/4-inch I.D. hollow stem auger. Inside of auger flushed with potable water. Well screen and riser pipe placed in borehole. Sand pack and then bentonite pellets placed as auger retracted. Neat cement grout to surface.	Fine to Medium Sand Fill 7.5' Fine to Medium Sand 26.2' Gravel 26.5' Silt 27.5' E.O.B.		Stickup: 2.81 2-inch diameter, stainless steel riser pipe 0' to 21.5' (585.7 - 564.2). 2-inch diameter, 5' long, #10 slot size stainless steel screen, 21.5 - 26.5' (564.2-559.2) Sandpack 16.5 - 26.5' (569.2- 559.2) Bentonite seal 14.5 - 16.5' (571.2-569.2) Cement grout 0 - 14.5' (585.7 - 571.2) 5-foot long protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

Sheet 1 of 1

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

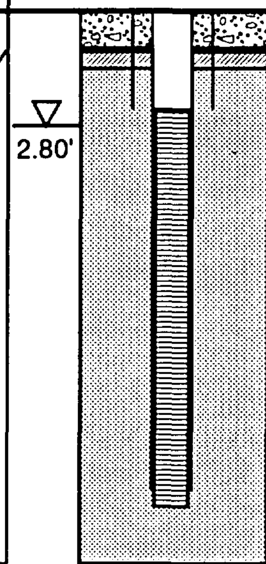
Project WCP RI/FS Phase I — Well No. P-101

Date Started 3/9/92

Date Completed 3/9/92 — Riser Pipe Elevation 588.14[1]

Field Inspector K. French (BEC)

Crew Chief P. Dickinson (WTD) — Ground Surface Elevation 585.0

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Hollow stem auger method. Borehole advanced from 0' to 14.0' (585.0-571.0) using 3 1/4-inch I.D. hollow stem auger. Inside of auger flushed with potable water. Well screen and riser pipe placed in the borehole. Sand pack and then bentonite pellets placed as auger retracted. Neat cement grout to surface. Water level was 5.94' below the top of the riser on 3/9/92 (582.2).	Silty Sand Fill 1.0' Fine to Medium Sand 14.0' E.O.B.	 	Stickup: 3.14' 1 1/4 -inch diameter, Schedule 40 PVC riser pipe 0' to 2.1' (585.0-582.9). 10.0 foot long, 1 1/4-inch diameter #10 slot size, Schedule 40 PVC screen 2.1- 12.1' (582.9-572.9) Sandpack 1.5' to 14.0' (583.5 - 571.0) Bentonite seal 1.0' to 1.5' (584.0- 583.5) Cement grout 0' to 1.0' (585.0-584.0) 5-foot long steel protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

Project WCP RI/FS Phase I

Well No. P-102

Date Started 3/12/92

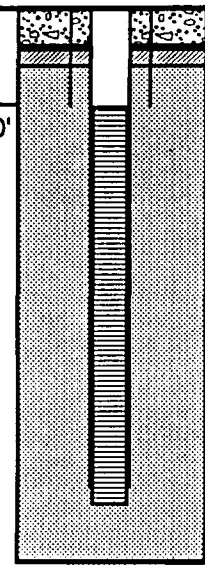
Date Completed 3/12/92

Riser Pipe Elevation 588.52[1]

Field Inspector K. French (BEC)

Crew Chief P. Dickinson (WTD)

Ground Surface Elevation 585.6

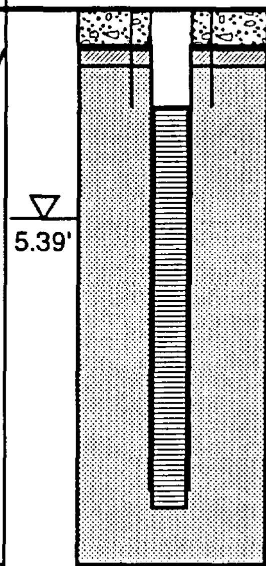
BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Hollow stem auger method. Borehole advanced from 0' to 14.0' (585.6-571.6)using 3 1/4-inch I.D. hollow stem auger. Inside of auger flushed with potable water. Well screen and riser pipe placed in the borehole. Sand pack and then bentonite pellets placed as auger retracted. Neat cement grout to surface. Water level was 5.52' below the top of the riser on 3/13/92 (583.0).	Medium to Coarse Sand Fill 2.0' Fine to Medium Sand 14.0' E.O.B.	2.60' 	Stickup: 2.92' 1 1/4 -inch diameter, Schedule 40 PVC riser pipe 0' to 2.2' (585.6-583.4). 9.96 foot long, 1 1/4-inch diameter Schedule 40 PVC #10 slot size screen 2.2-12.2' (583.4-573.4) Sandpack 1.5' to 14.0' (584.1- 571.6) Bentonite seal 1.0' to 1.5' (584.6- 584.1) Cement grout 0' to 1.0' (585.6-584.6) 5-foot long steel protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

Project WCP RI/FS Phase I
Well No. P-103
Date Started 3/12/92
Date Completed 3/13/92
Riser Pipe Elevation 589.44[1]
Field Inspector K. French (BEC)
Crew Chief P. Dickinson (WTD)
Ground Surface Elevation 586.4

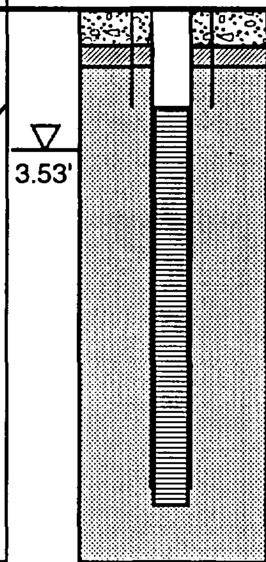
BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Hollow stem auger method. Borehole advanced from 0' to 14.5' (586.4-571.9)using 3 1/4-inch I.D. hollow stem auger. Inside of auger flushed with potable water. Well screen and riser pipe placed in the borehole. Sand pack and then bentonite pellets placed as auger retracted. Neat cement grout to surface. Water level was 5.39' below surface (581.01) on 3-13-92.	Fine to Medium Sand Fill 1.0' Fine to Medium Sand 14.0' E.O.B.		Stickup:3.04' 1 1/4 -inch diameter, Schedule 40PVC riser pipe 0' to 2.5' (586.4-583.9). 9.95 foot long, 1 1/4-inch diameter Schedule 40 PVC #10 slot size screen 2.5 - 12.5 (583.9-573.9) Sandpack 1.5' to 14.5' (584.9 - 571.9) Bentonite seal 1.0' to 1.5' (585.4 - 584.9) Cement grout 0' to 1.0' (586.4-585.4) 5-foot long steel protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

WELL LOG

BARR ENGINEERING CO.
Minneapolis, Minnesota

Project WCP RI/FS Phase I
Well No. P-104
Date Started 3/12/92
Date Completed 3/12/92
Riser Pipe Elevation 589.07[1]
Field Inspector K. French (BEC)
Crew Chief P. Dickinson (WTD)
Ground Surface Elevation 586.0

BOREHOLE CONSTRUCTION NOTES	LITHOLOGY	WELL CONSTRUCTION	WELL CONSTRUCTION NOTES
Hollow stem auger method. Borehole advanced from 0' to 14.0' (586.0-572.0)using 3 1/4-inch I.D. hollow stem auger. Inside of auger flushed with potable water. Well screen and riser pipe placed in the borehole. Sand pack and then bentonite pellets placed as auger retracted. Neat cement grout to surface. Water level was 3.5' below surface (582.5) on 3-13-92.	Poorly Graded Sand Fill 2.5' Fine to Medium Sand 14.0' E.O.B.	 	Stickup: 3.07' 1 1/4 -inch diameter, Schedule 40 PVC riser pipe 0' to 2.5' (586.0-583.5). 9.95 foot long, 1 1/4-inch diameter Schedule 40 PVC #10 slot size screen 2.1-12.0' (583.9-574.0) Sandpack 1.5' to 14.5' (584.5- 571.5) Bentonite seal 1.0' to 1.5' (585.0-584.5) Cement grout 0' to 1.0' (586.0-585.0) 5-foot long steel protective casing with locking cap. Three protective posts installed.

Comments: [1] Elevation in feet MSL
Vertical Scale : 1" = 5'

Sheet 1 of 1

Appendix F

***Field Log Data Sheets** - Well Development and Water Level Data Sheets*

Field Log Data Sheets - Well Development

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW-3S

Client NSG/WCP　　Project No. 1 3 / 4 9 - 0 0 3 J S L 3 1

Location: Waukegan, IL　　Date: 3/25/92　　Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N	Y	1. 2:35/750	9.3	490		7.30	
Casing Dia: (in.)	2	2. 2:40/825	9.0	490		7.09	
Total Depth (ft.)	12	3. 2:45/900	9.0	490		7.02	
Static Depth (ft.)	--	4. 2:50/975	8.9	490		7.07	
Water Depth:	5'(TOC)	5.					
Well Vol. (gal.)	1.5	6.					
Purge Method:	pump + surge	7.					
Samp. Method:	—	Appearance: slight oil sheen					
Start Time:	1:45	Odor: none					
Stop Time:	2:50	Comments:					
Duration: (min.)	65						
Rate, gpm:	15						
Volume Purged:	975						

Samplers: TWW, JMF　　Others Present:

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW-4S

Client NSG/WCP Project No. 13/49-003 JS431

Location: Waukegan, IL Date: 3/25/92 Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N	Y	1. 6:15/675	8.5	550		7.40	
Casing Dia: (in.)	2	2. 6:20/750	8.4	550		7.21	
Total Depth (ft.)	12.0	3. 6:25/825	8.3	550		7.30	
Static Depth (ft.)	--	4. 6:40/900	8.3	550		7.36	
Water Depth:	6.8 (TOC)	5. 6:45/975	8.3	550		7.39	
Well Vol. (gal.)	1.2	6.					
Purge Method:	pump + surge	7.					
Samp. Method:	—	Appearance: clear, after a few minutes					
Start Time:	5:30	Odor: yes -					
Stop Time:	6:46	Comments: - pump stopped fr 6:26-6:35 + restarted.					
Duration: (min.)	76						
Rate, gpm:	±15						
Volume Purged:	975						

Samplers: JMF, TWW Others Present:

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW-5S

Client NSG/WCP Project No. 13-49-003JSL31

Location: Waukegan IL Date: 3/25/92 Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N	Y	1. 4:20/75	8.3	320		7.57	
Casing Dia: (in.)	2	2. 4:25/100	8.2	320		7.59	
Total Depth (ft.)	13.2	3. 4:30/125	8.3	320		7.51	
Static Depth (ft.)	—	4. 4:35/175	8.1	312		7.60	
Water Depth:	5.8' (TOC)	5. 4:40/225	8.1	310		7.69	
Well Vol. (gal.)	1.6	6. 4:45/275	7.9	309		7.70	
Purge Method:	pump + surge	7.					
Samp. Method:	—	Appearance: clear, after 50 gals					
Start Time:	4:05	Odor: none					
Stop Time:	4:50	Comments: - increased pumping rate fr. 5 to 10 gpm at 4:31 - pump shut off for 1 minute + restarted					
Duration: (min.)	45						
Rate, gpm:	5-10						
Volume Purged:	325						

Samplers: JMF, TWW Others Present:

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW-6S

Client NSG/WCP Project No. 1314911-003 JS1431

Location: Waukegan IL Date: 3/27/92 Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N	Y	1. 12:25/	9.6	1000		7.66	
Casing Dia: (in.)	2	2. 12:30/	9.5	1000		7.76	
Total Depth (ft.)	13.5	3. 12:35/	9.9	1000		7.75	
Static Depth (ft.)	—	4.					
Water Depth:	8.0(TOC)	5.					
Well Vol. (gal.)	1.3	6.					
Purge Method:	pump+ surge	7.					
Samp. Method:	—	Appearance: clear					
Start Time:	10:30	Odor: yes					
Stop Time:	12:35	Comments:					
Duration: (min.)	125						
Rate, gpm:	6gpm						
Volume Purged:	750						

Samplers: TWW, JMF Others Present: WTD

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: [illegible]

Client: NSG/WCP   Project No. [illegible]

Location: [illegible]   Date: [illegible]   Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N	Y	1. 6:19/448	[illegible]	750		[illegible]	
Casing Dia: (in.)	2	2. [illegible]/455	[illegible]	750		[illegible]	
Total Depth (ft.)	[illegible]7.8	3. [illegible]/462	[illegible]	[illegible]		[illegible]	
Static Depth (ft.)	—	4.					
Water Depth:	5.9 (TOC)	5.					
Well Vol. (gal.)	3.3	6.					
Purge Method:	pump surge	7.					
Samp. Method:	—	Appearance: [illegible], no silt					
Start Time:	5:15	Odor: [illegible]					
Stop Time:	[illegible]:31	Comments: [illegible]					
Duration: (min.)	7[illegible]						
Rate, gpm:	7						
Volume Purged:	550						

Samplers: TWW, JMF   Others Present:

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

MONITORING WELL DEVELOPMENT

VELL NUMBER MW-04 D

WELL DIAMETER ~~2.0~~ 2" SS

TOTAL DEPTH 32.0

DEPTH TO WATER BEFORE DEVELOPMENT 6.8 TOC

DEPTH TO WATER AFTER DEVELOPMENT 6.8 TOC

PROJECT NO. 3568

DATE March 23, 92

DEVELOPED BY PD

DESCRIPTION OF DEVELOPMENT METHOD

~~1,7 BK hand pump 75 gal. March 23,92~~

Trash Pump 5gal/min 3-26-92

surge w/Bailer

Trash pump 250gal 3-27-92

VOLUME OF WATER REMOVED FROM WELL ~~1,500~~ 1,950

CLARITY OF WATER IN WELL BEFORE DEVELOPMENT Silty dark Brn /gray

CLARITY OF WATER IN WELL AFTER DEVELOPMENT Silty Lt. Brn

VOLUME OF WATER ADDED TO WELL none.

SOURCE OF WATER ADDED TO WELL none

TIME SPENT FOR DEVELOPMENT ~~7~~ 9 hours

COMMENTS:

ENVIRONMENTAL DRILLING
WTD
A DIVISION OF LONGYEAR COMPANY

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW-4D

Client: NSG/WCP Project No. 13-49-003-JS-431

Location: Waukegan, IL Date: 3/26/92 Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @25	pH	Eh
Barr Lock: Y N	Y	1. 3:45/1400	11.4	7000		8.55	
Casing Dia: (in.)	2	2. 3:50/1425	11.1	7000		8.49	
Total Depth (ft.)	32'	3. 3:55/1450	11.7	7000		8.45	
Static Depth (ft.)	–	4. 4:00/1475	11.5	7000		8.44	
Water Depth:	6.8 TOC	5. 4:05/1500	11.5	7000		8.44	
Well Vol. (gal.)	3.8	6.					
Purge Method:	pump + surge	7.					
Samp. Method:	–	Appearance: cloudy, slightly [illegible]					
Start Time:	11:30	Odor: yes -					
Stop Time:	4:06	Comments: [illegible]					
Duration: (min.)	276	[illegible] 1130 3 gpm					
Rate, gpm:	see comments	[illegible] 5 gpm					
Volume Purged:	1500						

Samplers: TWW, JMP Others Present:

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW-4P

Client: NSG

Project No. B 49 - 0035 L 31

Location: Waukegan, IL

Date: 3/27/92

Sample Time:

General		Stabilization Test					
		TIME/VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N	Y	1. 2:22/335	12.3	6500		8.50	
Casing Dia: (in.)	2	2. 2:27/360	12.2	7000		8.50	
Total Depth (ft.)	32	3. 2:32/390	11.9	7000		8.48	
Static Depth (ft.)	-	4. 2:37/425	12.1	7000		8.48	
Water Depth:	6.8 (TOC)	5.					
Well Vol. (gal.)	3.8	6.					
Purge Method:	Pump & Surge	7.					
Samp. Method:	—	Appearance: GOLDEN BROWN - LITE FOAM					
Start Time:	12:30	Odor: YES					
Stop Time:	2:40	Comments: SEDIMENT cleaned up @ Between last pumping and ~200 gal this pumping.					
Duration: (min.)	130						
Rate, gpm:	±3						
Volume Purged:	425	volumes were measured directly.					

Samplers: JMF / TWW Others Present: WTD

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW-5D

Client NSG-WCP Project No. 1314910035231

Location: Waukegan, IL. Date: 3/27/92 Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	±.5 TEMP CENT.	±5 COND. umhos	COND. @25	±0.1 pH	Eh
Barr Lock: Y N	Y	1. 820/300	8.6	2600 ~~2580~~		8.40	
Casing Dia: (in.)	2	2. 825/325	9.3	2600 ~~2580~~		8.39	
Total Depth (ft.)	26.0	3. 830/350	8.9	2600 ~~2580~~		8.42	
Static Depth (ft.)	—	4. 835/375	8.8	2600 2580		8.45	
Water Depth:	7.8 (TOC)	5.					
Well Vol. (gal.)	3.2	6.					
Purge Method:	Pump & surge	7.					
Samp. Method:	—	Appearance: golden					
Start Time:	7:10 AM	Odor: yes					
Stop Time:	8:40	Comments: 70 min/300 GAL = ~5 GPM					
Duration: (min.)	90						
Rate, gpm:	5 ±	clear - slightly golden after several well volumes.					
Volume Purged:	415 GAL						

Samplers: JMF / TWW Others Present: WTD

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW-6D

Client NSG/WCP — Project No. 13-49-903J5431

Location: Waukegan, IL — Date: 3/27/92 — Sample Time: ______

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @25	pH	Eh
Barr Lock: Y N	Y	1. 10:08/215	10.8	8500		8.33	
Casing Dia: (in.)	2	2. 10:13/	10.8	8500		8.30	
Total Depth (ft.)	26.5	3. 10:18/250	10.7	8500		8.28	
Static Depth (ft.)	—	4.					
Water Depth:	8.0 (TOC)	5.					
Well Vol. (gal.)	3.2	6.					
Purge Method:	Pump + surge	7.					
Samp. Method:	—	Appearance: golden brown, slightly cloudy					
Start Time:	9 am	Odor: yes					
Stop Time:	10:20	Comments:					
Duration: (min.)	80						
Rate, gpm:	3						
Volume Purged:	250						

Samplers: TWW/JMF — Others Present: WTD

gen ___ VOC ___ COD ___ TOC ___ semi-volatile ___ f. metal ___ t. metal ___

nitro ___ cyanide ___ oil & grease ___ 200 ml filter ___ 500 ml filter ___

others ___

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: P-101

Client: NSG GXP Project No. 1B-1491-0103-5K-311

Location: Waukegan IL Date: 5/24/92 Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	±.5 TEMP CENT.	±5 COND. umhos	COND. @25	±0ø pH	Eh
Barr Lock: Y N	Y	1. 5:32/20GAL	7.2	1050		8.02	
Casing Dia: (in.)	1 1/4	2. 5:42/30GAL	6.7	1050		7.79	
Total Depth (ft.)		3. 5:52/40GAL	6.6	1050		7.76	
Static Depth (ft.)		4. 6:02/50GAL	6.6	1050		7.76	
Water Depth:		5.					
Well Vol. (gal.)		6.					
Purge Method:		7.					
Samp. Method:		Appearance:					
Start Time:	5:12	Odor:					
Stop Time:	6:12	Comments: 5GAL/4MIN — 5GAL/5MIN cloudy — 5GAL then clear					
Duration: (min.)	60						
Rate, gpm:	~1GPM						
Volume Purged:	60						

Samplers: JMF Others Present: WT

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: P-102

Client: NSG-WCP   Project No. 1 3 1 4 9 - 0 0 4 J S F S 1

Location: Waukegan, IL.   Date: 3/24/92   Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	± .5 TEMP CENT.	± 5 COND. umhos	COND. @ 25	± 0.1 pH	Eh
Barr Lock: Y N	Y	1. 3:15/25 GAL	10.6	680		7.30	
Casing Dia: (in.)	1 1/4	2. 3:25/35 GAL	10.7	680		7.39	
Total Depth (ft.)		3. 3:35/45 GAL	10.4	680		7.46	
Static Depth (ft.)	15.0'	4. 3:45/55 GAL	10.5	680		7.50	
Water Depth:	6.3	5. 3:55/65 GAL	10.2	680 ~~710~~			7.49
Well Vol. (gal.)		6.					
Purge Method:		7.					
Samp. Method:		Appearance: Cloudy - 10 GAL Then clear					
Start Time:	2:50	Odor: NONE - ABOVE BACKGROUND					
Stop Time:	4:00	Comments:					
Duration: (min.)	70						
Rate, gpm:	~1 GPM						
Volume Purged:	70						

Samplers: JMF   Others Present: WTD

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: P-103

Client: NSG-WCP

Project No. 13-49-003 JSL 31

Location: Waukegan, IL.

Date: 3/24/92

Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N	Y	1. 11:11 / 30GAL	10.6	1020		7.66	
Casing Dia: (in.)	1 1/4	2. 11:25 / 40GAL	10.7	990		7.67	
Total Depth (ft.)		3. 11:40 / 55GAL	9.3	980		7.84	
Static Depth (ft.)	15.4'	4. 11:52 / 67GAL	8.8	~~905~~ 900 ✓		7.80 ✓	
Water Depth:	7.6	5. 12:02 / 77GAL	8.8 ✓	~~910~~ 900 ✓		7.89 ✓	
Well Vol. (gal.)		6. 12:12 / 87GAL	8.9 ✓	~~920~~ 900 ✓		7.80 ✓	
Purge Method:	Air Lift	7.					
Samp. Method:		Appearance: cloudy 0-10 GAL — Then clear.					
Start Time:	10:35	Odor: NONE					
Stop Time:	12:25	Comments: CI @ 15.4' @ START; H2O 7.6' " " } Below TOR; START AIR LIFT 10:35 AM @ ~1 GPM (5GAL/6 min); (1) slightly cloudy (2) clear (3) clear (4) clear					
Duration: (min.)	110						
Rate, gpm:	~1 GPM						
Volume Purged:	110 ±						

Samplers: JMF Others Present: WTD

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: P-104

Client: NSG - WCP   Project No. 1131-14A-010 B JB K 131

Location: Waukegan, IL.   Date: 3/24/92   Sample Time: ______

General		Stabilization Test					
		TIME/ VOLUME	±.5 TEMP CENT.	±5 COND. umhos	COND. @ 25	±0.1 pH	Eh
Barr Lock: Y N	Y	1. 1:47/42 GAL	11.1	720		7.51	
Casing Dia: (in.)	1 1/4	2. 1:57/52 GAL	9.3	700		7.26	
Total Depth (ft.)		3. 2:07/62 GAL	9.8	700		7.03	
Static Depth (ft.)	15.4	4. 2:17/72 GAL	9.4	700		7.06	
Water Depth:	6.6	5. 2:27/82 GAL	9.4	700		7.07	
Well Vol. (gal.)		6.					
Purge Method:	AIRLIFT	7.					
Samp. Method:		Appearance: cloudy 10 GAL - Then clear					
Start Time:	1:05	Odor: NONE - ABOVE BACKGROUND.					
Stop Time:	2:30	Comments: slight oily film and slight yellow color to H2O - But clear of sediment.					
Duration: (min.)	85						
Rate, gpm:	1 GPM						
Volume Purged:	85						

Samplers: JMF   Others Present: WTD

gen ____ VOC ____ COD ____ TOC ____ semi-volatile ____ f. metal ____ t. metal ____

nitro ____ cyanide ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ______

Water Level Data Sheets

WATER LEVEL DATA SHEET

PROJECT NAME WAKegan/WCP RI/FS

SAMPLERS JEG
DATE 4/7/92
PAGE ____ OF ____

WELL NUMBER	MEASURING POINT ELEVATION	WATER LEVEL DEPTH	TOTAL WELL DEPTH	WATER LEVEL ELEVATION	COMMENTS
P101	588.14	5.84	15.22	582.30	
P102	588.52	5.50	15.09	583.02	
P103	589.44	6.99	15.42	582.45	
P104	589.07	6.27	15.06	582.80	
Harbor		~~6.59~~	~~15.48~~		Not measured at correct location
MW3S	588.24	5.54	15.04	582.70	
MW3D	588.23	5.59	30.84	582.64	
MW4S	589.17	6.62	15.45	582.55	
MW4D	589.06	6.54	34.34	582.52	
MW5S	587.89	7.32	16.28	580.57	
MW5D	588.47	7.93	28.62	580.54	
MW6S	588.45	7.70	16.75	580.75	
MW6D	588.51	7.81	29.53	580.70	
MW1S	587.76	5.97	19.75	581.79	
MW1D	587.62	5.84	29.75	581.78	
~~Harbor~~			~~14.38~~		

ATER LEVEL DATA SHEET

ROJECT NAME WAKegan/WCP RI/FS

SAMPLERS JEG
DATE 4/9/92
PAGE ____ OF ____

WELL NUMBER	MEASURING POINT ELEVATION	WATER LEVEL DEPTH	TOTAL WELL DEPTH	WATER LEVEL ELEVATION	COMMENTS
P101	588.14	5.87	15.22	582.27	
P102	588.52	5.59	15.09	582.93	
P103	589.44	7.06	15.42	582.38	
P104	589.07	6.34	15.06	582.73	
Harbor		~~5.26~~	~~15.48~~		Not measured at the correct location
MW3S	588.24	5.65	15.04	582.59	
MW3D	588.23	5.69	30.84	582.54	
MW4S	589.17	6.68	15.45	582.49	
MW4D	589.06	6.65	34.34	582.41	
MW5S	587.89	7.34	16.28	580.55	
MW5D	588.47	7.94	28.62	580.53	
MW6S	588.45	7.71	16.75	580.74	
MW6D	588.51	7.84	29.53	580.67	
MW1S	587.76	6.01	19.75	581.75	
MW1D	587.62	5.88	29.75	581.74	
~~Harbor~~		~~5.27~~	~~14.38~~		

WATER LEVEL DATA SHEET

PROJECT NAME WAKegan/WCP RI/FS

SAMPLERS KAF/TWW
DATE 4-15-92
PAGE 1 OF 1

WELL NUMBER	MEASURING POINT ELEVATION	WATER LEVEL DEPTH	TOTAL WELL DEPTH	WATER LEVEL ELEVATION	COMMENTS
P101	588.14	6.05	15.22	582.09	17:36
P102	588.52	5.82	15.09	582.70	18:03
P103	589.44	7.42	15.42	582.02	17:29
P104	589.07	6.65	15.06	582.42	17:32
Harbor	584.65	4.3	~~[illegible]~~	580.4	Elev. 584.65 measured below
MW3S	588.24	5.49	15.04	582.75	
MW3D	588.23	5.53	30.84	582.70	
MW4S	589.17	6.75	15.45	582.42	
MW4D	589.06	6.72	34.34	582.34	
MW5S	587.89	7.14	16.28	580.75	
MW5D	588.47	7.74	28.62	580.73	
MW6S	588.45	7.61	16.75	580.84	
MW6D	588.51	7.74	29.53	580.77	
MW1S	587.76	6.03	19.75	581.73	
MW1D	587.62	5.91	29.75	581.71	
~~Harbor~~			~~[illegible]~~		

WATER LEVEL DATA SHEET

PROJECT NAME WAKegan/WCP RI/FS

SAMPLERS MES/LCK
DATE 4-21-92
PAGE 1 OF 1

WELL NUMBER	MEASURING POINT ELEVATION	WATER LEVEL DEPTH	TOTAL WELL DEPTH	WATER LEVEL ELEVATION	COMMENTS
P101	588.14	6.10	15.22	582.04	
P102	588.52	5.91	15.09	582.61	
P103	589.44	7.42	15.42	582.02	
P104	589.07	6.64	15.06	582.43	
Harbor	584.65	~~4.26~~ 4.3 LAH	[illegible]	580.4	Is marked w/ the Elev. 584.65. Is located on the north seawall. Take measurement from between seawall + walkway the benchmark X.
MW3S	588.24	5.56	15.04	582.68	
MW3D	588.23	5.60	30.84	582.63	
MW4S	589.17	6.76	15.45	582.41	
MW4D	589.06	6.72	34.34	582.34	
MW5S	587.89	7.10	16.28	580.79	
MW5D	588.47	7.69	28.62	580.78	
MW6S	588.45	7.56	16.75	580.89	
MW6D	588.51	7.68	29.53	580.83	
MW1S	587.76	5.97	19.75	581.79	
MW1D	587.62	5.86	29.75	581.76	
[illegible]			[illegible]		

WATER LEVEL DATA SHEET

PROJECT NAME WAKEGAN / WCP RI/FS

SAMPLERS LCK
DATE 5-7-92
PAGE 1 OF 1

WELL NUMBER	MEASURING POINT ELEVATION	WATER LEVEL DEPTH	TOTAL WELL DEPTH	WATER LEVEL ELEVATION	COMMENTS
P101	588.14	6.34	15.22	581.80	
P102	588.52	6.16	15.09	582.36	
P103	589.44	7.63	15.42	581.81	
P104	589.07	6.92	15.06	582.15	
MW3D	588.23	6.00	30.84	582.23	
MW3S	588.24	5.97	15.04	582.27	
MW4D	589.06	6.99	34.34	582.07	
MW4S	589.17	7.02	15.45	582.15	
* MW5D	588.47	7.75	28.62	580.72	Riser cover was very dif. to remove. Pry bar is valuable tool to have along.
MW5S	587.89	7.16	16.28	580.73	
MW6D	588.51	7.70	29.53	580.81	
MW6S	588.45	7.59	16.75	580.86	
MW1D	587.62	6.02	29.75	581.60	
MW1S	587.76	6.13	19.75	581.63	
** Harbor	584.65	4.20		580.5	value reported is middle range of wave action (±½")

* Pry lid

** waveaction $\pm\frac{1}{2}$ inch.

WATER LEVEL DATA SHEET

PROJECT NAME WAKEGAN /WCP/ RI/FS

SAMPLERS LCK
DATE 5-27-92
PAGE 1 OF 1

WELL NUMBER	MEASURING POINT ELEVATION	WATER LEVEL DEPTH SOLINST	POWERS WELL SOUNDER WS-1	TOTAL WELL DEPTH	WATER LEVEL ELEVATION USING SOLINST	COMMENTS
P101	588.14	6.48	6.48 6.51	15.22	581.66	
P102	588.52	6.37	6.38 6.42	15.09	582.15	
P103	589.44	7.94	7.94 7.98	15.42	581.50	
P104	589.07	7.28	7.28 7.32	15.06	581.79	
MW3D	588.23	6.29	6.10 6.31	30.84	581.94	
MW3S	588.24	6.25	6.26 6.29	15.04	581.99	Solinst used before and after Powers. Readings on Solinst = Exact match.
MW4D	589.06	7.34	7.27 7.36	34.34	581.72	
MW4S	589.17	7.36	7.38 7.40	15.45	581.81	Audible | V 1st hit (2-3 mAmps) A Full 15 mAmps
MW5D	588.47	7.73	7.72 7.76	28.62	580.74	
MW5S	587.89	7.13	7.12 7.16	16.28	580.76	
MW6D	588.51	7.74	7.68 7.74	29.53	580.77	
MW6S	588.45	7.63	7.63 7.67	16.75	580.82	
MW1D	587.62	6.23	6.09 6.30	29.75	581.39	
MW1S	587.76	6.35	6.36 6.39	19.75	581.41	
Harbor	584.65	4.05 4.16	4.04 4.15		580.5	1st 1 beep/15 sec. | 2nd SAME Constant on (15 sec.) | SAME

Appendix G

Slug Test Data and Evaluation

TABLE G-1

SLUG TEST PARAMETERS
BOUWER AND RICE METHOD

Well	Depth to Static Water Level (Below Top of Casing) (ft) 4/15/92	Average Initial Drawdown (y_0) (ft)	Static Height of Water in Well (L_w) (ft)	Saturated Screen Length (L_e) (ft)	Radius of Casing (r_c) (ft)	Radius of Filter Pack (r_w) (ft)	Saturated Thickness of Aquifer (H) (ft)
MW-1S	6.03	2.1	13.72	5.0	0.083	0.25	24.0
MW-1D	5.91	1.8	23.84	5.0	0.083	0.25	24.0
MW-3S	5.49	0.18	9.55	9.55	0.083	0.427	26.1
MW-3D	5.53	1.6	25.31	5.0	0.083	0.427	25.7
MW-4S	6.75	0.19	8.70	8.70	0.083	0.427	27.7
MW-4D	6.72	1.5	27.62	4.5	0.083	0.427	27.7
MW-5S	7.14	0.17	9.14	9.14	0.083	0.427	21.1
MW-5D	7.74	1.6	20.88	4.7	0.083	0.427	20.9
MW-6S	7.61	0.19	9.14	9.14	0.083	0.427	21.6
MW-6D	7.74	2.0	21.79	5.0	0.083	0.427	21.8

BARR ENGINEERING COMPANY

MEMORANDUM

TO: WCP RI/FS File (13/49-003JSL33)

FROM: KAF

DATE: May 22, 1992

RE: Slug Test Evaluation
L_e and r_c Parameters for Bouwer and Rice Method

Parameter L_e

Because the filter pack and aquifer were both poorly graded sand, it was assumed that the filter pack and aquifer had similar hydraulic conductivities. For this reason, the length of the intake zone (L_e) was assumed to be the length of the screen and not the length of the sand pack.

Parameter r_c

According to the Bouwer and Rice method, an equivalent value of r_c must be substituted for r_c when the water is rising or falling within the gravel pack as well as the well casing. The formula for the equivalent r_c is:

$$\text{equiv } r_c = \sqrt{(1-n)r_c^2 + nr_w^2}$$

n = porosity of gravel pack
r_w = radius of gravel pack
r_c = radius of casing

This formula assumes that the entire porosity of a gravel pack drains into the well casing during the slug test. An equivalent radius was calculated for wells screened across the water table (MW-3S, -4S, -5S, and -6S). The hydraulic conductivities estimated using this radius were several times higher than the hydraulic conductivities estimated for the deeper wells (sand pack fully saturated), although there was no geologic explanation for the difference. When the actual r_c value instead of the equivalent r_c value was used, the hydraulic conductivity estimates for the water table wells were similar to those for the deeper wells. The conclusion was that the equivalent r_c was too large and that the entire porosity of the gravel pack cannot have drained into the well casing. The following calculation shows that only 3 percent of the total volume of the exposed filter pack drained into the well casing:

Volume of water drained from filter pack into screen:

$$\Pi r_c^2 (0.8 \text{ ft}) 1$$

where 1 = porosity of the well casing, and

where y_0 = 1 foot (initial drawdown)

y_t = 0.2 foot (beginning of aquifer response on graph)

$y_0 - y_t$ = 0.8 foot (recovery due to draining of filter pack)

Volume of filter pack that can drain into well:

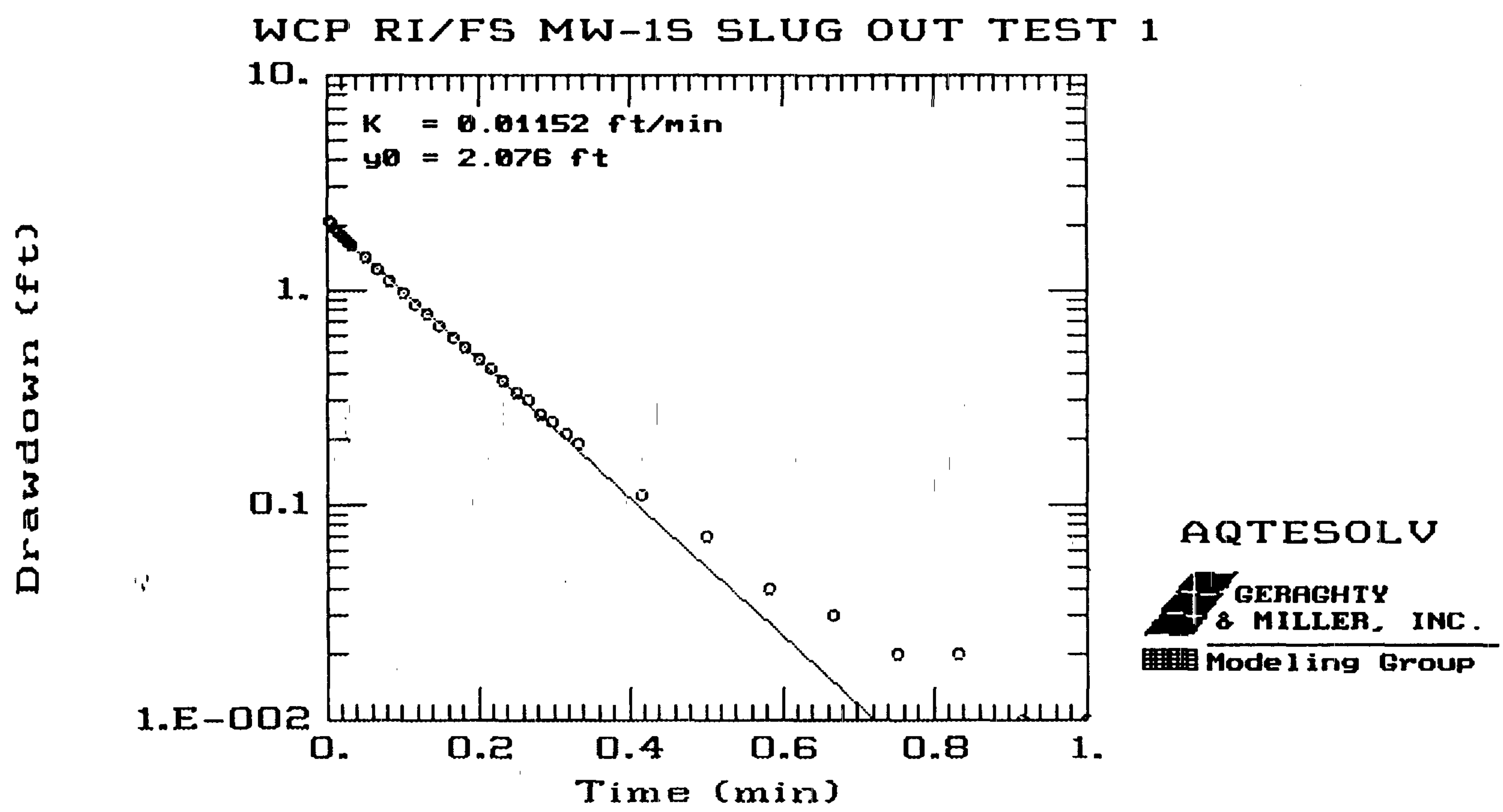
$$\Pi (r_w^2 - r_c^2) y_0$$

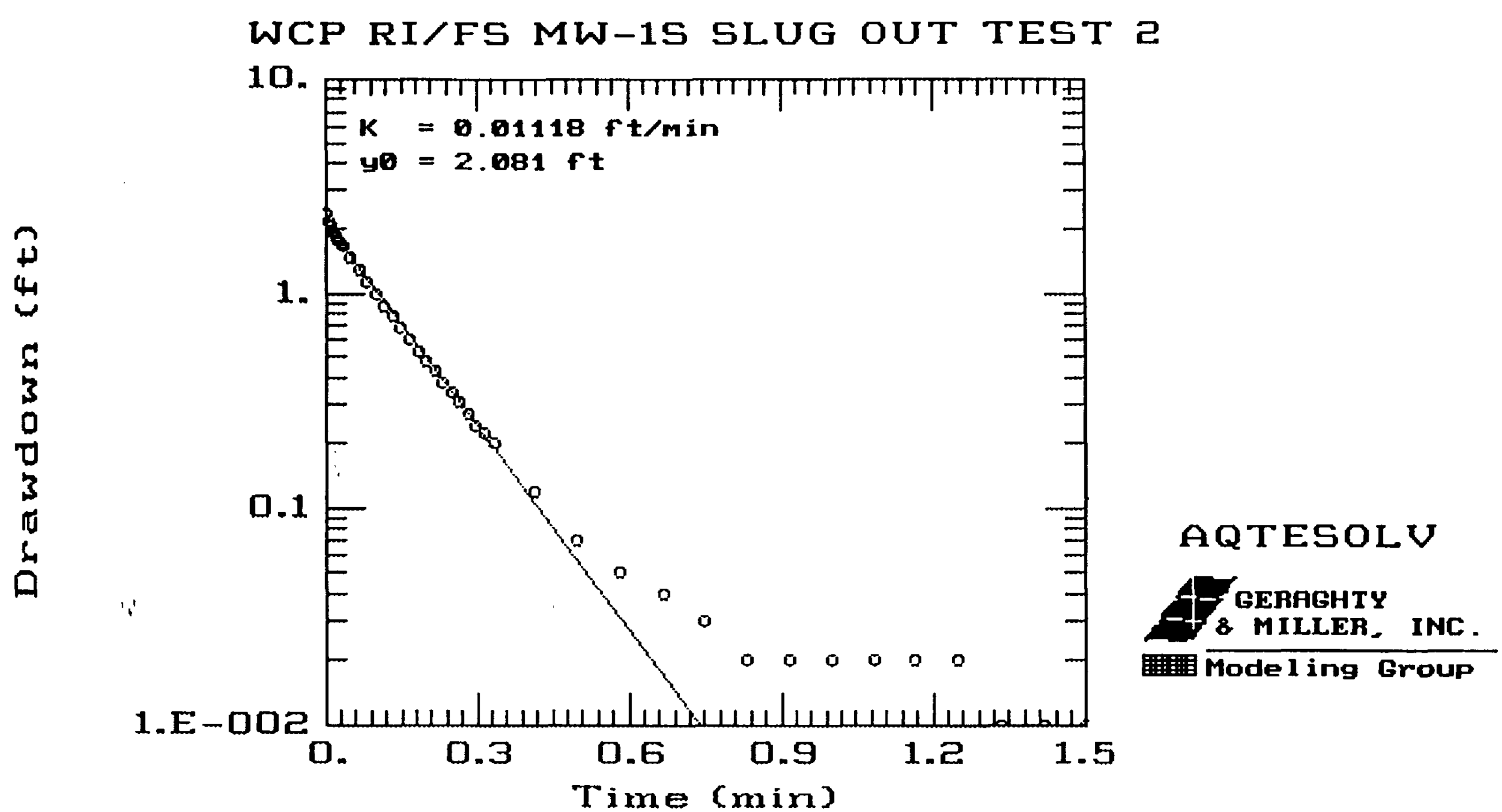
Drained porosity of filter pack (x):

$$x = \frac{\Pi r_c^2 (0.8)}{\Pi (r_w^2 - r_c^2) y_0} = 0.03$$

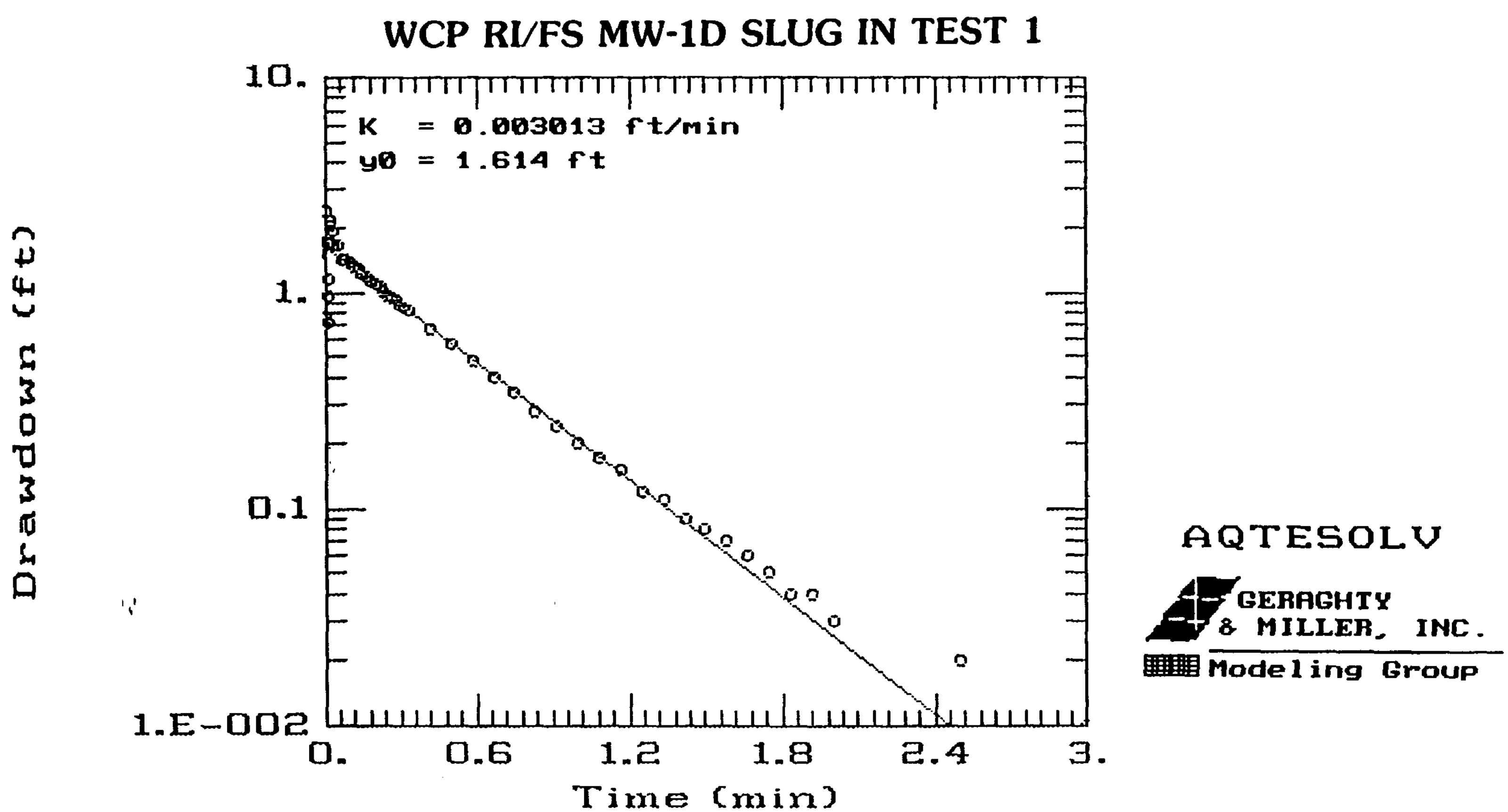
where: r_c = 0.083 foot, r_w = 0.427 foot, and y_0 = 1.0 foot

Because only 3 percent of the total filter pack volume drained into the well during the slug test, the filter pack can be assumed to have been essentially saturated throughout the test and the actual casing radius (r_c) can be used instead of the equivalent radius.


WCP RI/FS MW-1S SLUG OUT TEST 1
K = 0.01152 ft/min
y0 = 2.076 ft
10.
1.
0.1
1.E-002
Drawdown (ft)
0.
0.2
0.4
0.6
0.8
1.
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group

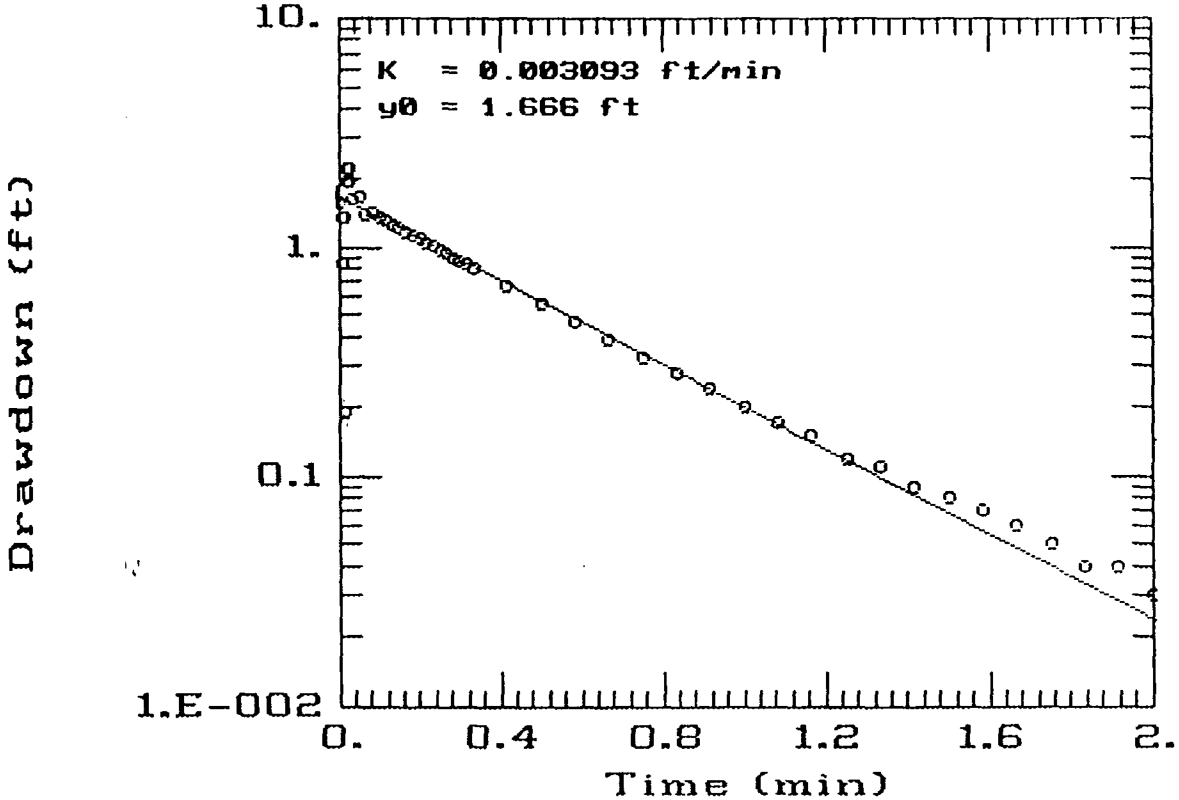


WCP RI/FS MW-1S SLUG OUT TEST 2
K = 0.01118 ft/min
y0 = 2.081 ft
10.
1.
0.1
1.E-002
Drawdown (ft)
0.
0.3
0.6
0.9
1.2
1.5
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group



WCP RI/FS MW-1D SLUG IN TEST 1
K = 0.003013 ft/min
y0 = 1.614 ft
10.
1.
0.1
1.E-002
0.
0.6
1.2
1.8
2.4
3.
Time (min)
Drawdown (ft)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group

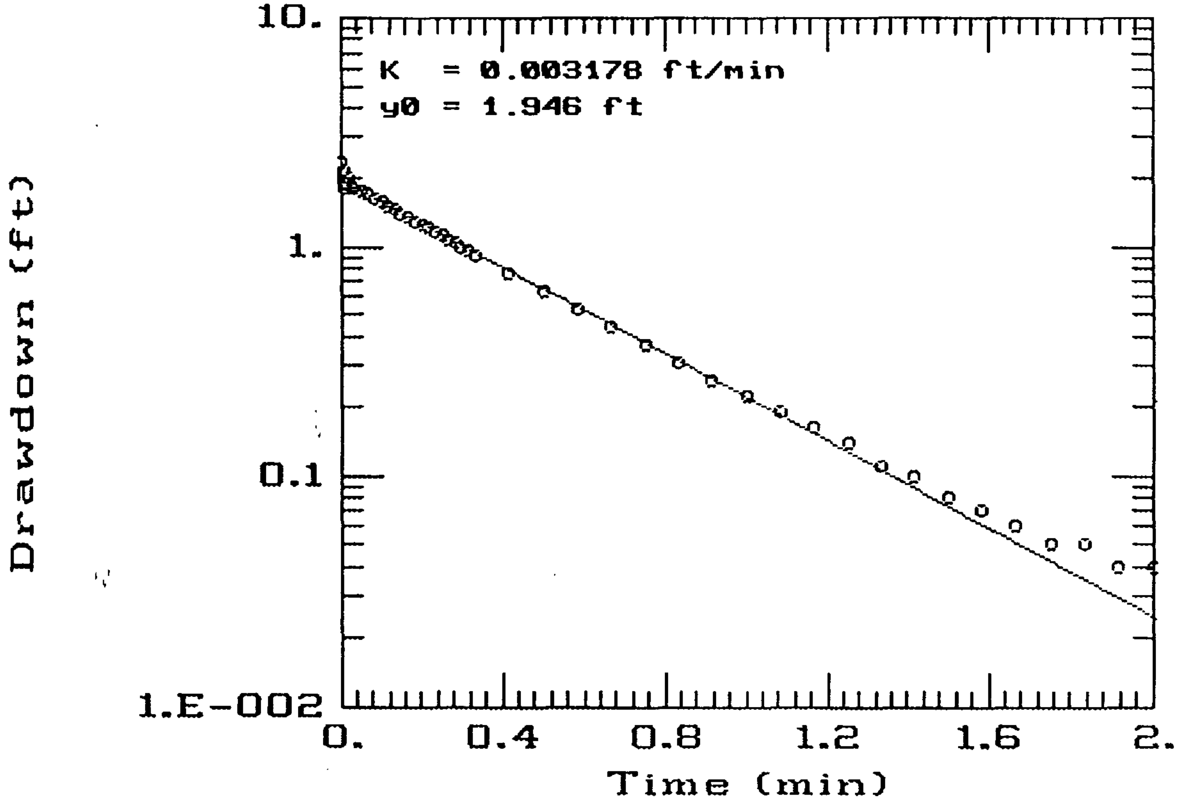
WCP RI/FS MW-1D SLUG IN TEST 2



AQTESOLV

GERAGHTY & MILLER, INC.
Modeling Group

WCP RI/FS MW-1D SLUG OUT TEST 1

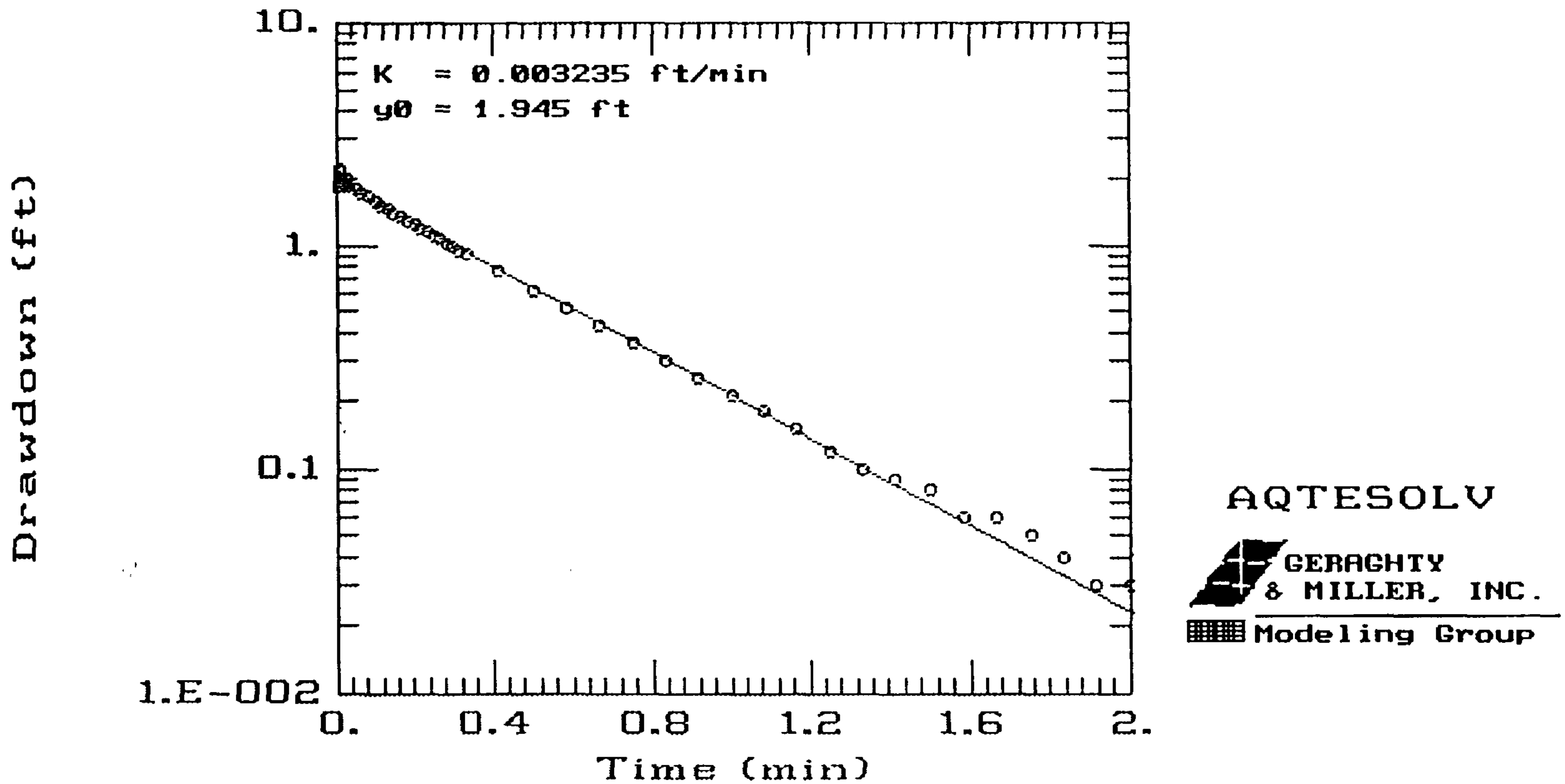


AQTESOLV

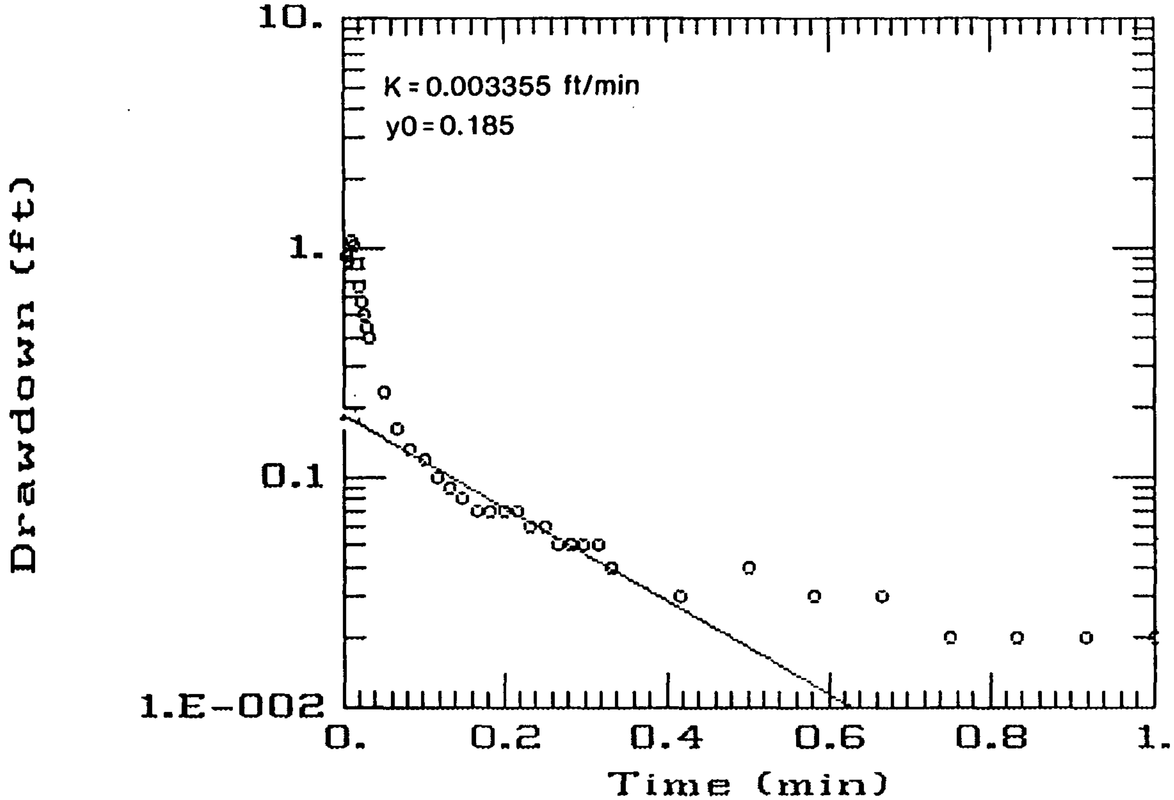
GERAGHTY & MILLER, INC.

Modeling Group

WCP RI/FS MW-1D SLUG OUT TEST 2



WCP RI/FS MW-3S SLUG OUT TEST 1



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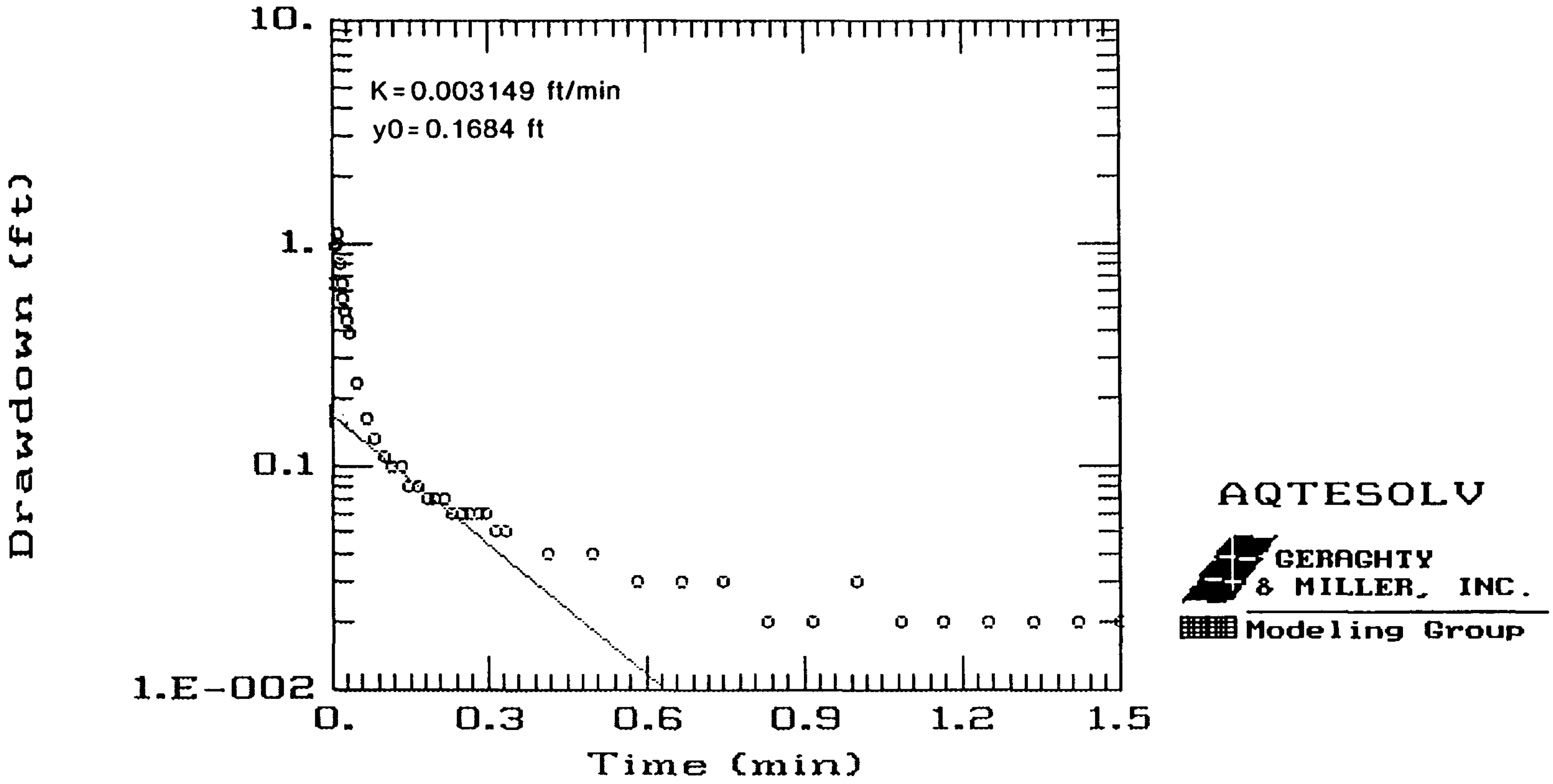
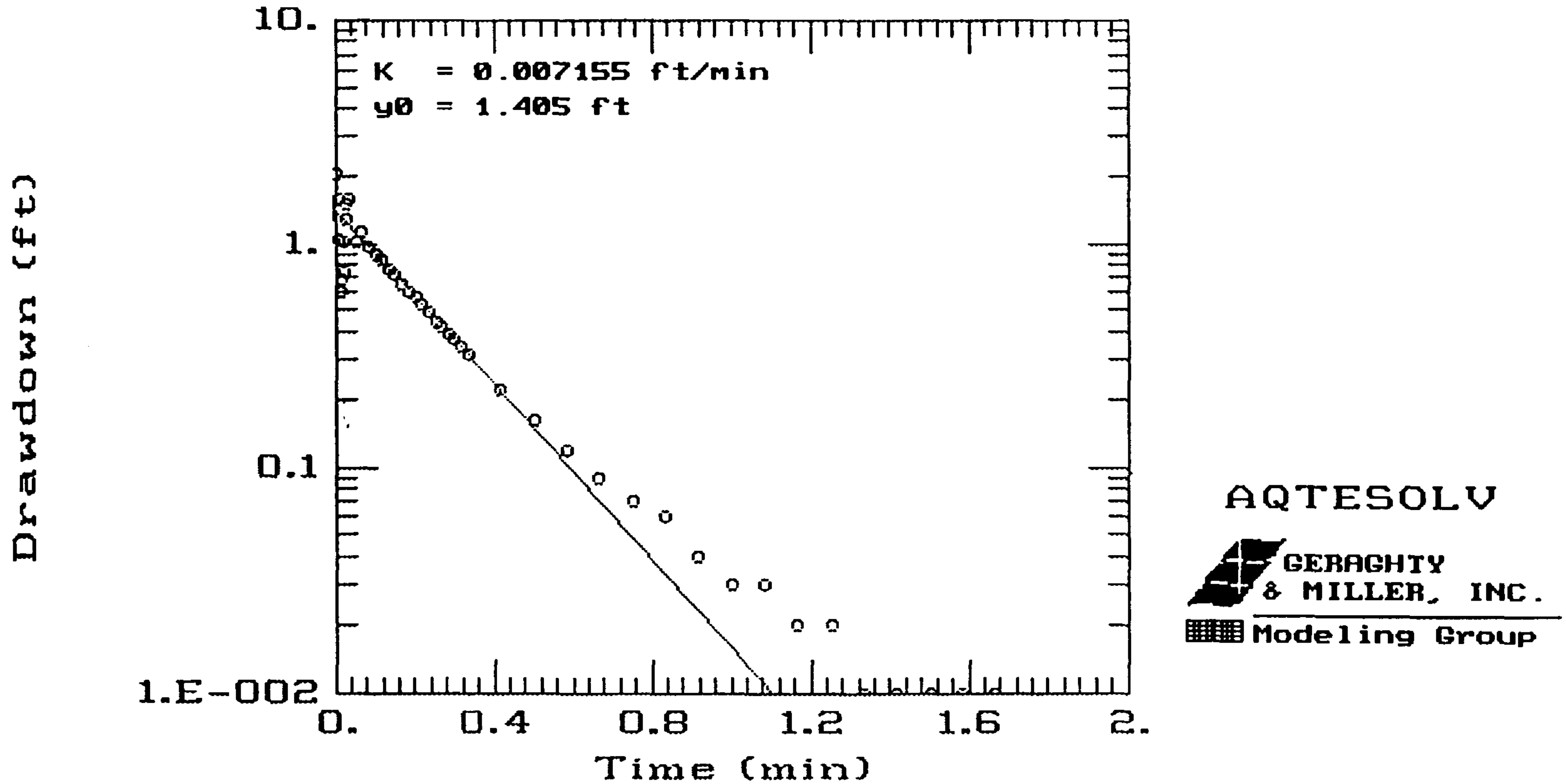
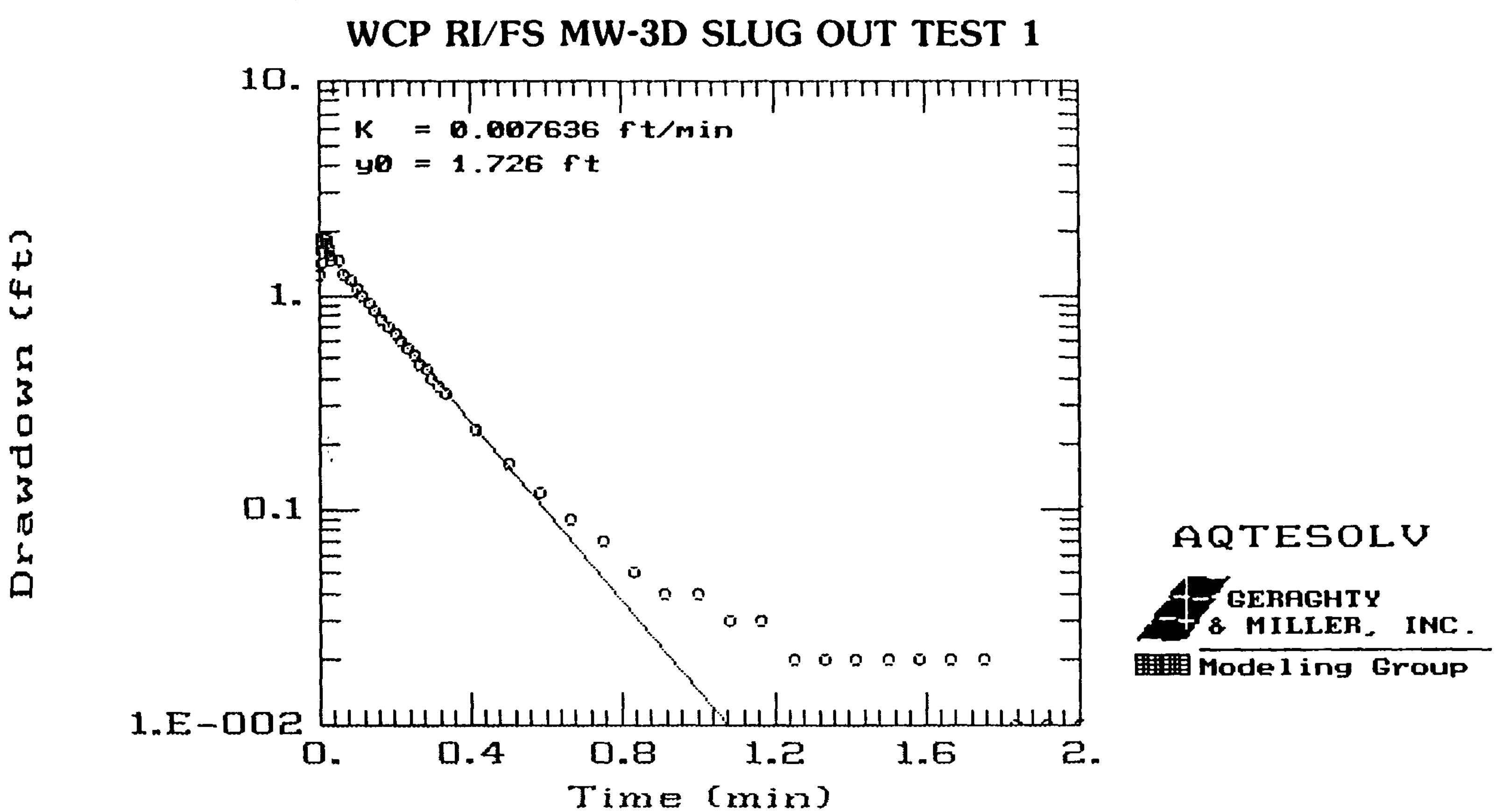
Modeling Group

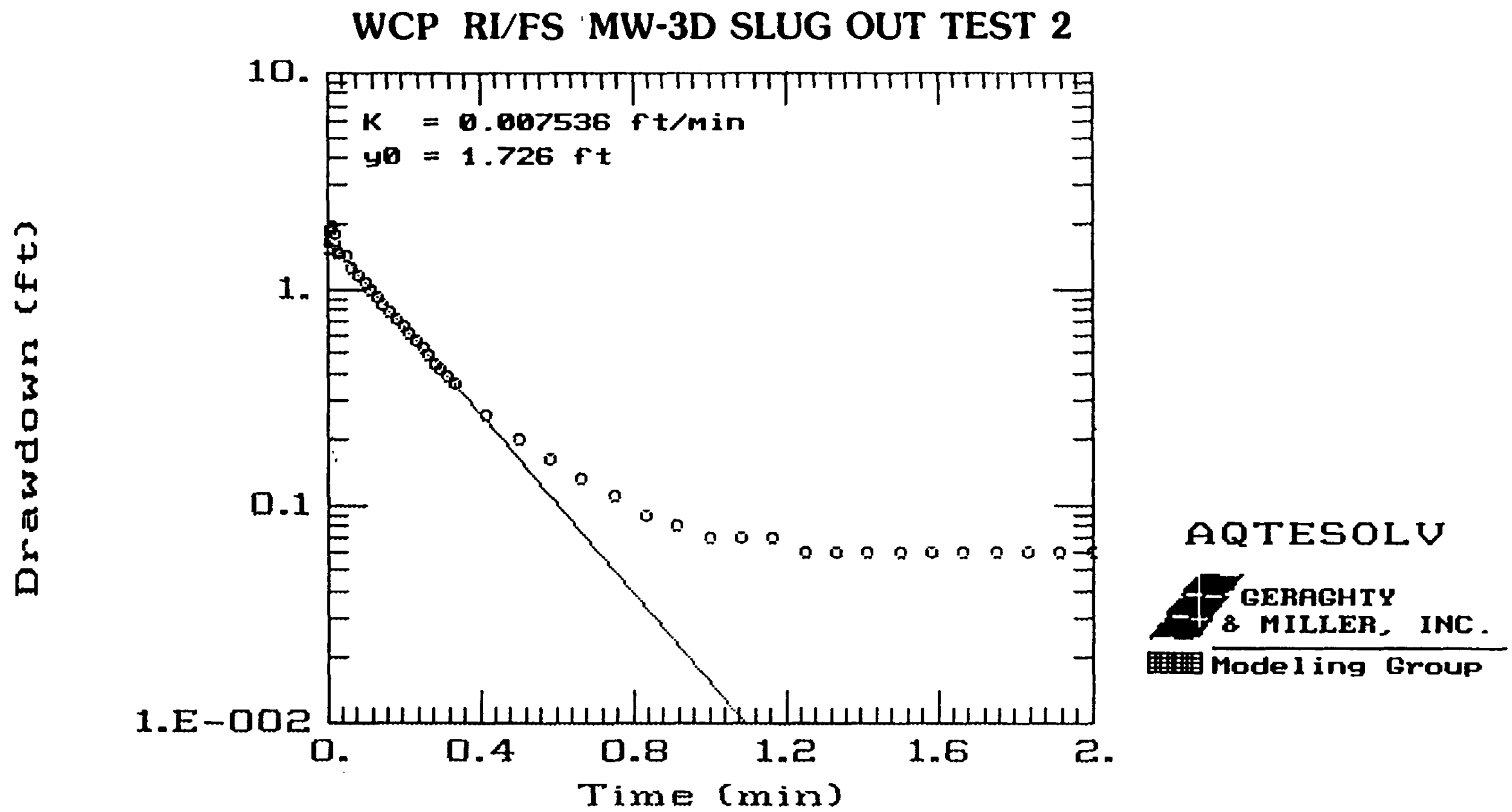
WCP RI/FS MW-3S SLUG OUT TEST 2



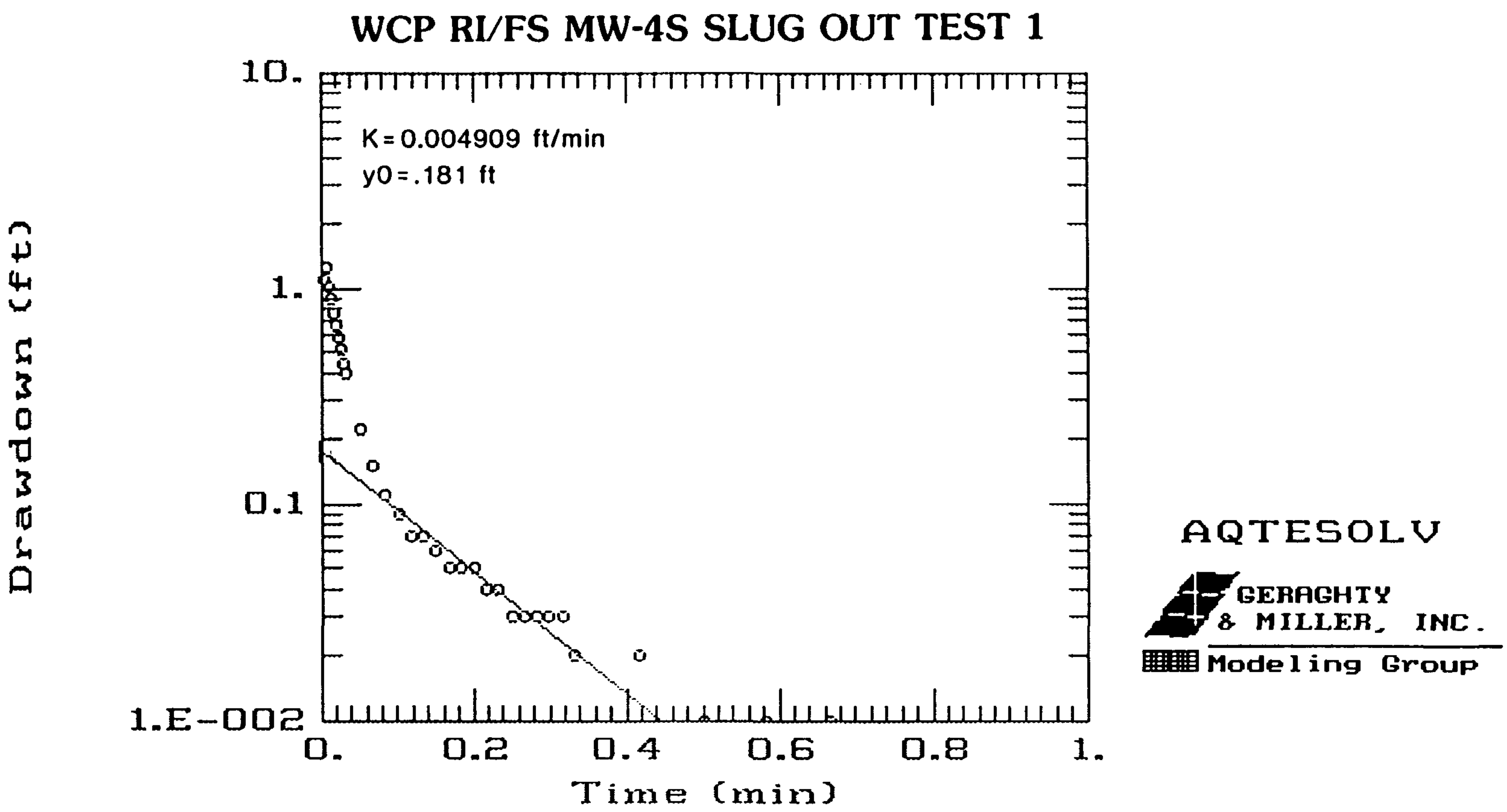
WCP RI/FS MW-3D SLUG IN TEST 2

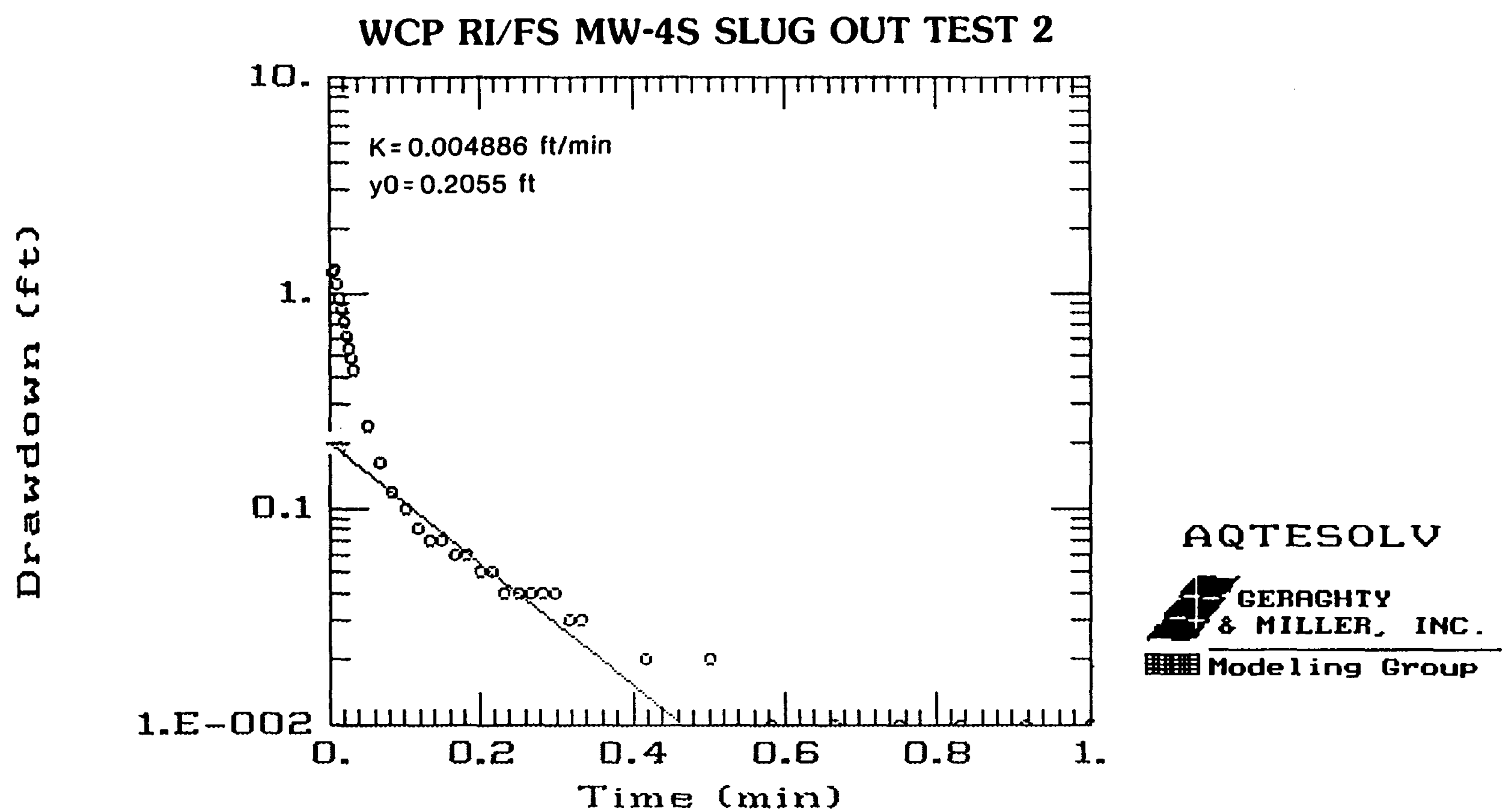



WCP RI/FS MW-3D SLUG OUT TEST 1
K = 0.007636 ft/min
y0 = 1.726 ft
Drawdown (ft)
Time (min)
10.
1.
0.1
1.E-002
0.
0.4
0.8
1.2
1.6
2.
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group



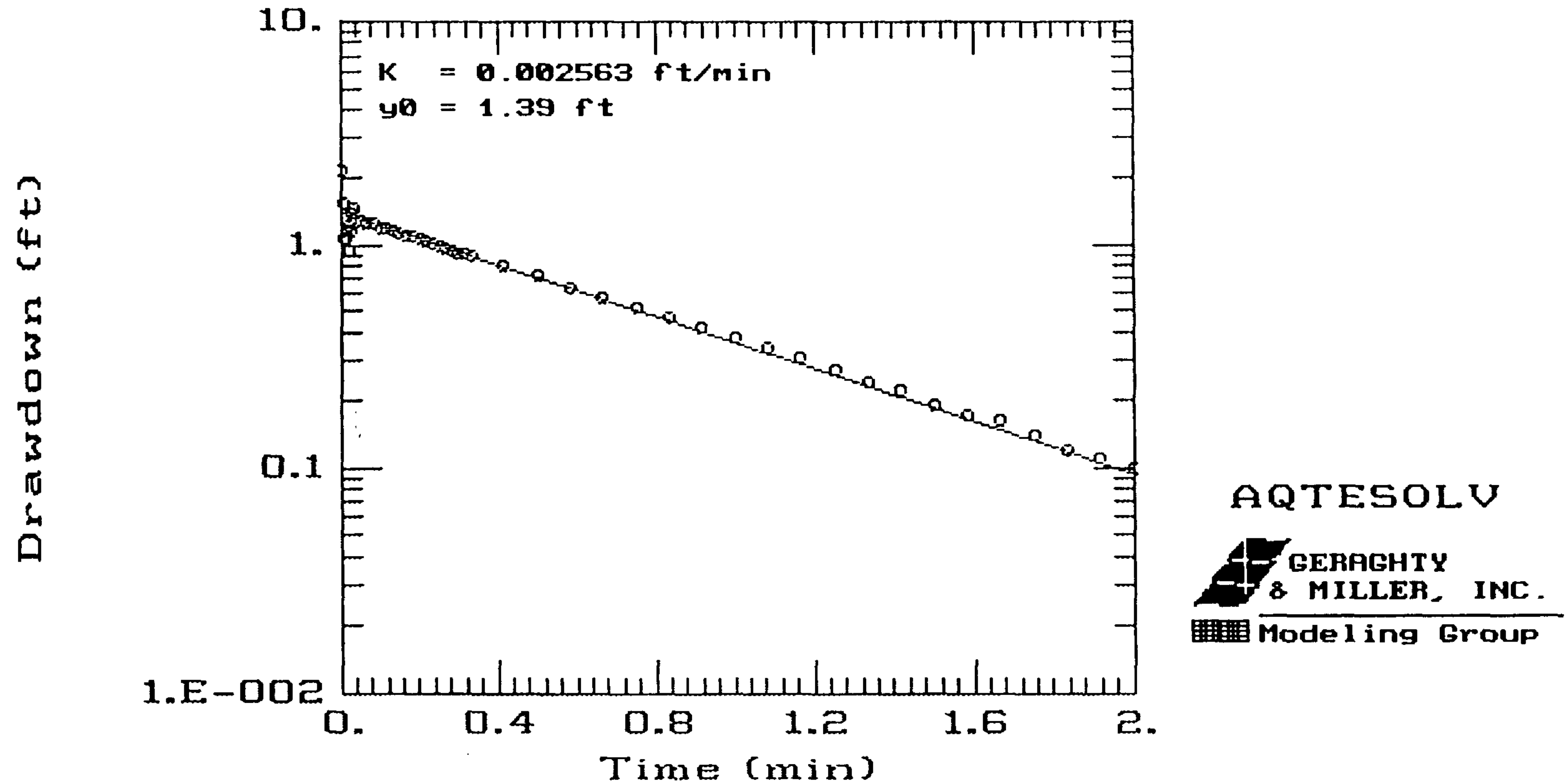
WCP RI/FS MW-3D SLUG OUT TEST 2
K = 0.007536 ft/min
y0 = 1.726 ft
Drawdown (ft)
10.
1.
0.1
1.E-002
0.
0.4
0.8
1.2
1.6
2.
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group

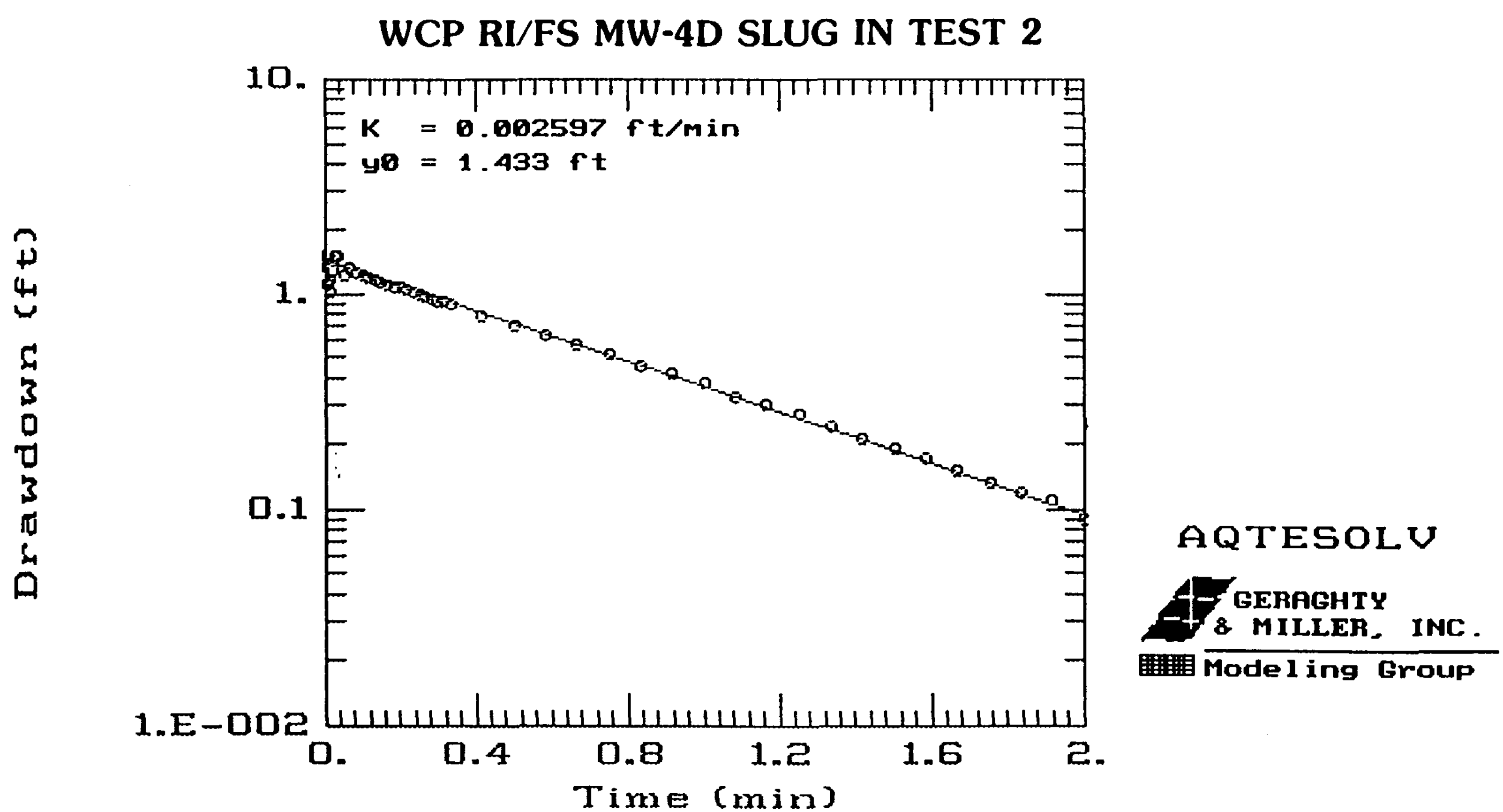

WCP RI/FS MW-4S SLUG OUT TEST 1
K=0.004909 ft/min
y0=.181 ft
10.
1.
0.1
1.E-002
0.
0.2
0.4
0.6
0.8
1.
Time (min)
Drawdown (ft)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group

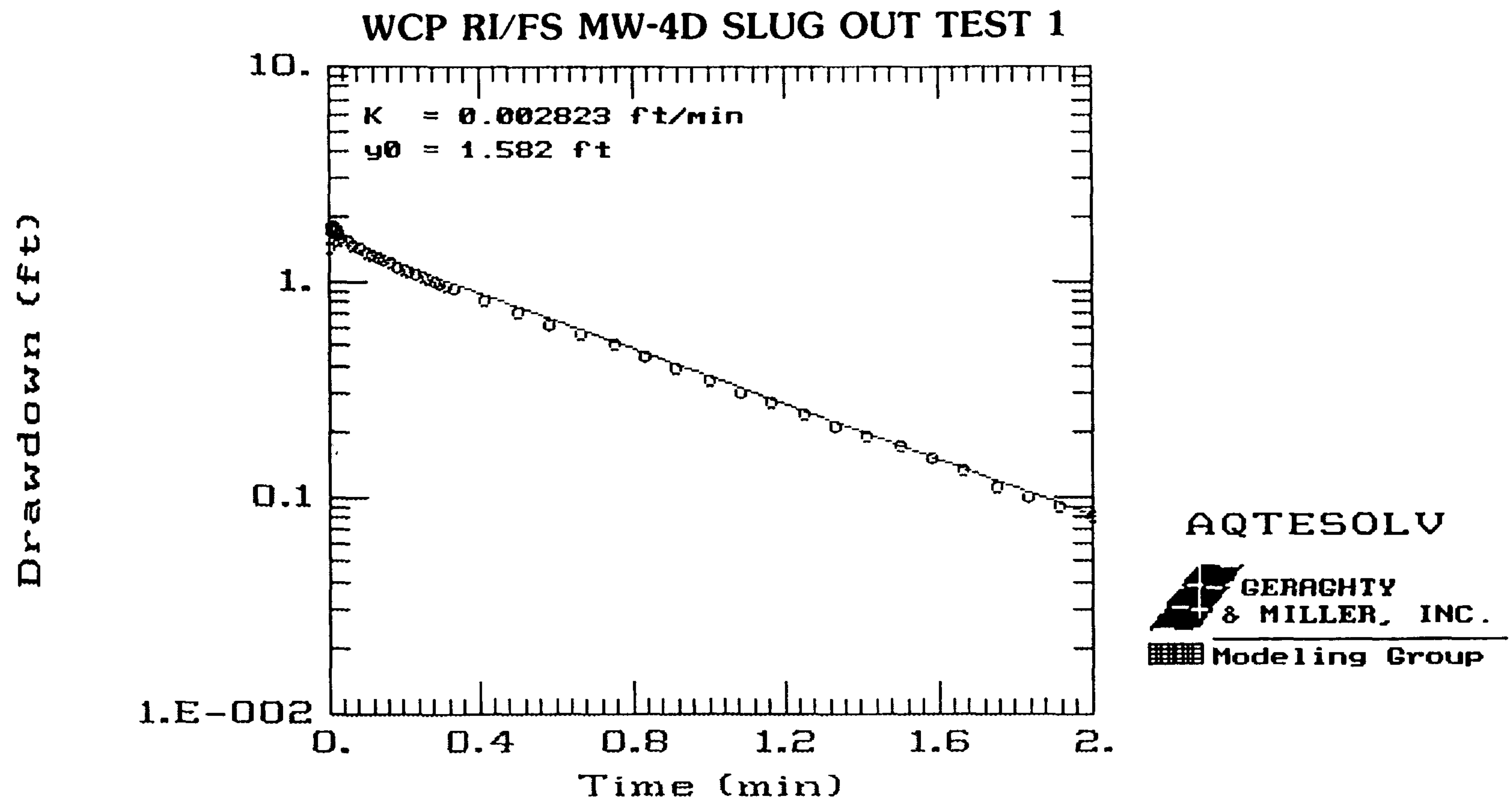


WCP RI/FS MW-4S SLUG OUT TEST 2
K = 0.004886 ft/min
y0 = 0.2055 ft
10.
1.
0.1
1.E-002
Drawdown (ft)
0.
0.2
0.4
0.6
0.8
1.
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group

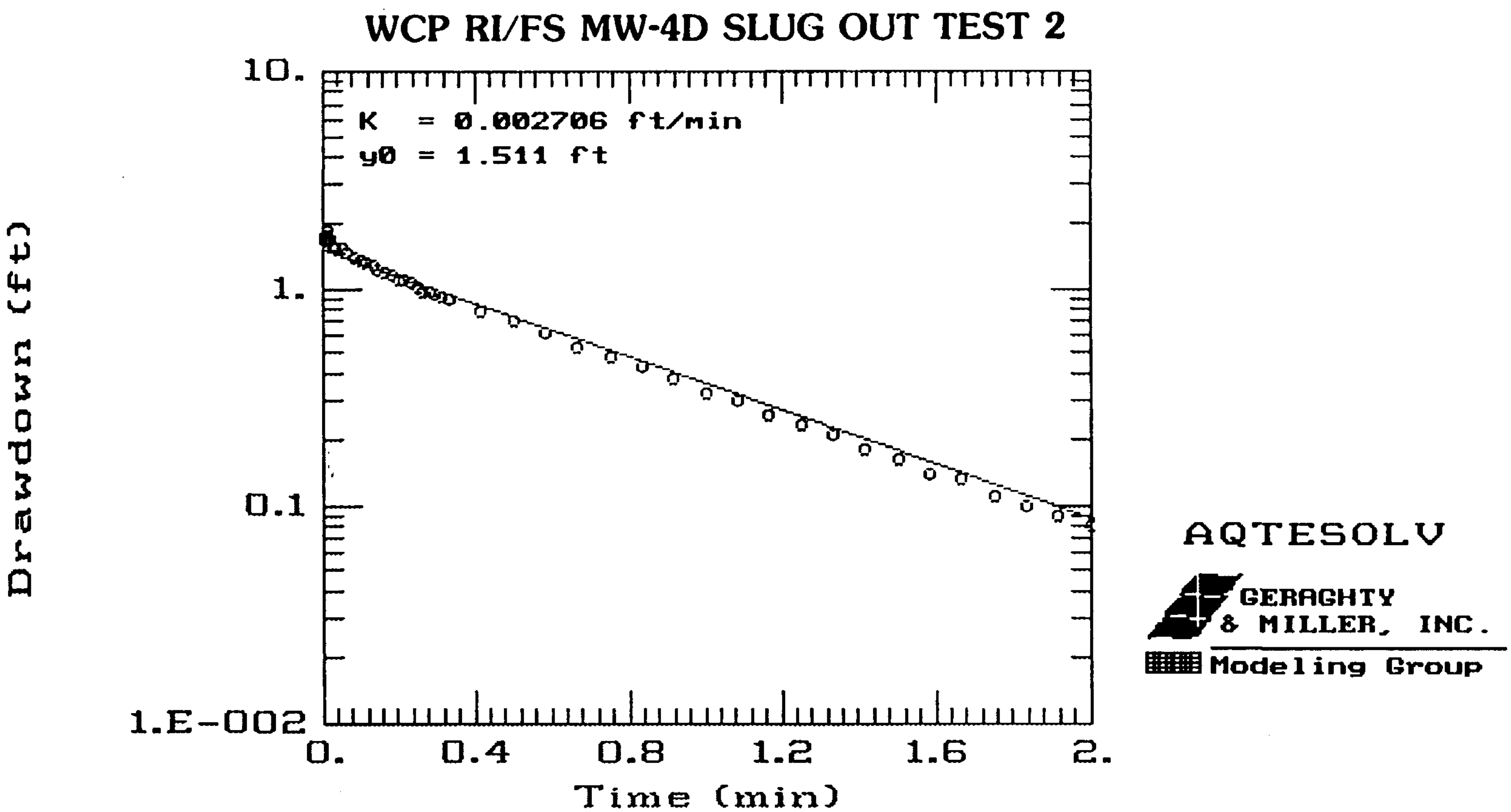
WCP RI/FS MW-4D SLUG IN TEST 1

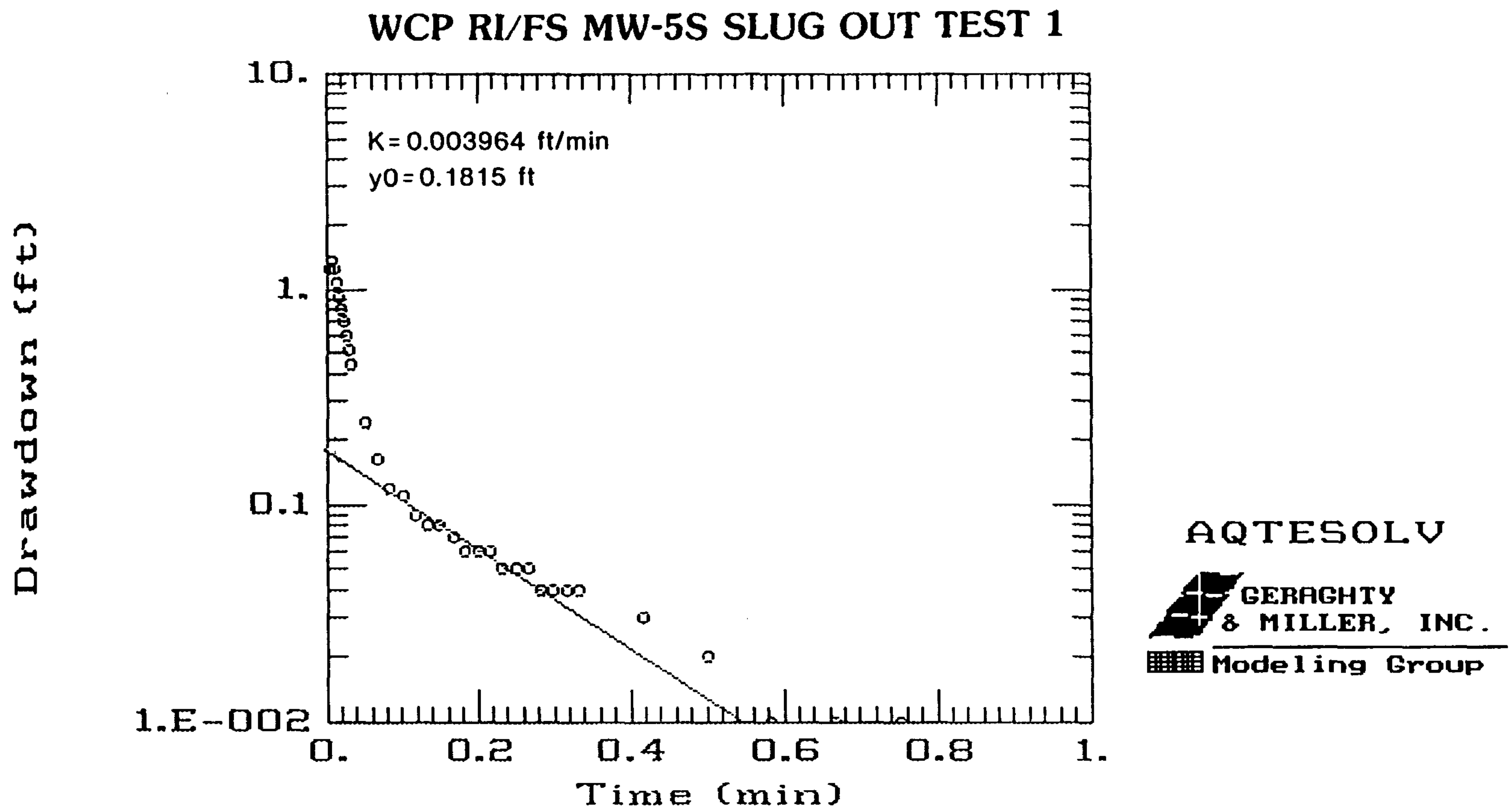



WCP RI/FS MW-4D SLUG IN TEST 2
K = 0.002597 ft/min
y0 = 1.433 ft
10.
1.
0.1
1.E-002
Drawdown (ft)
0.
0.4
0.8
1.2
1.6
2.
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group

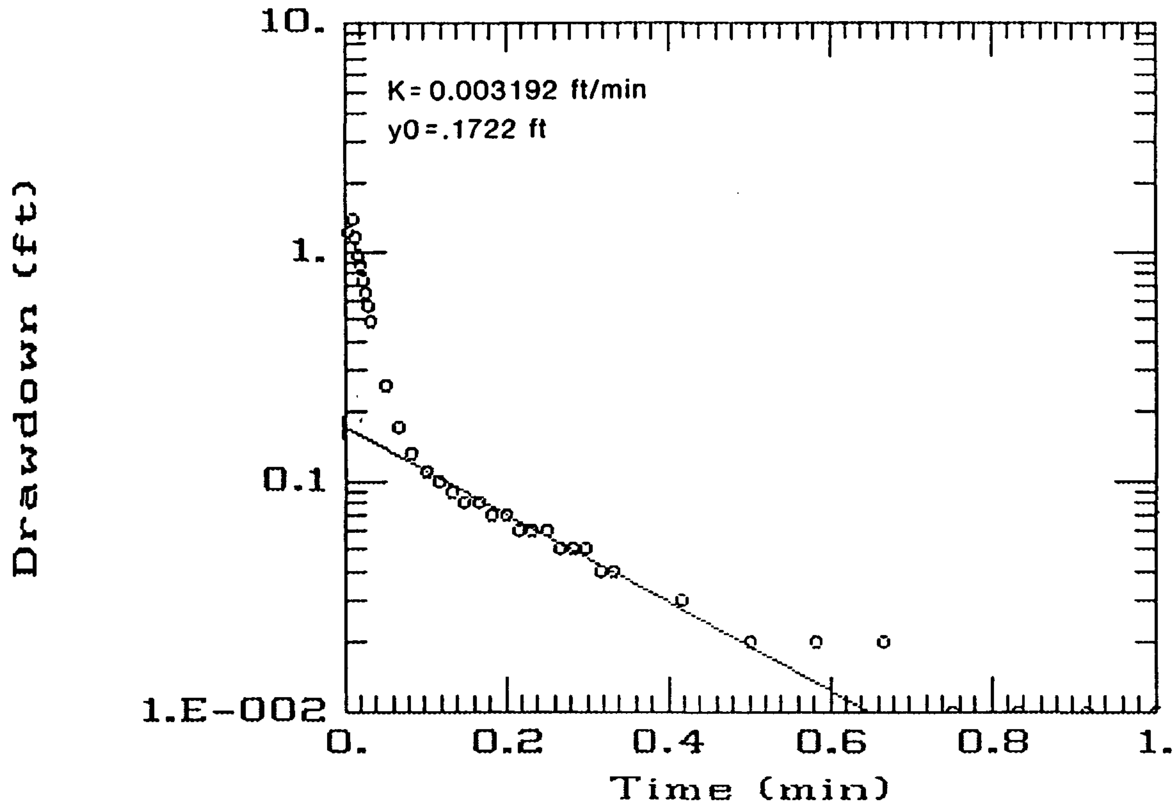


WCP RI/FS MW-4D SLUG OUT TEST 1
K = 0.002823 ft/min
y0 = 1.582 ft
10.
1.
0.1
1.E-002
0.
0.4
0.8
1.2
1.6
2.
Time (min)
Drawdown (ft)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group


WCP RI/FS MW-4D SLUG OUT TEST 2
K = 0.002706 ft/min
y0 = 1.511 ft
10.
1.
0.1
1.E-002
0.
0.4
0.8
1.2
1.6
2.
Time (min)
Drawdown (ft)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group


WCP RI/FS MW-5S SLUG OUT TEST 1
K=0.003964 ft/min
y0=0.1815 ft
10.
1.
0.1
1.E-002
Drawdown (ft)
0.
0.2
0.4
0.6
0.8
1.
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group

WCP RI/FS MW-5S SLUG OUT TEST 2

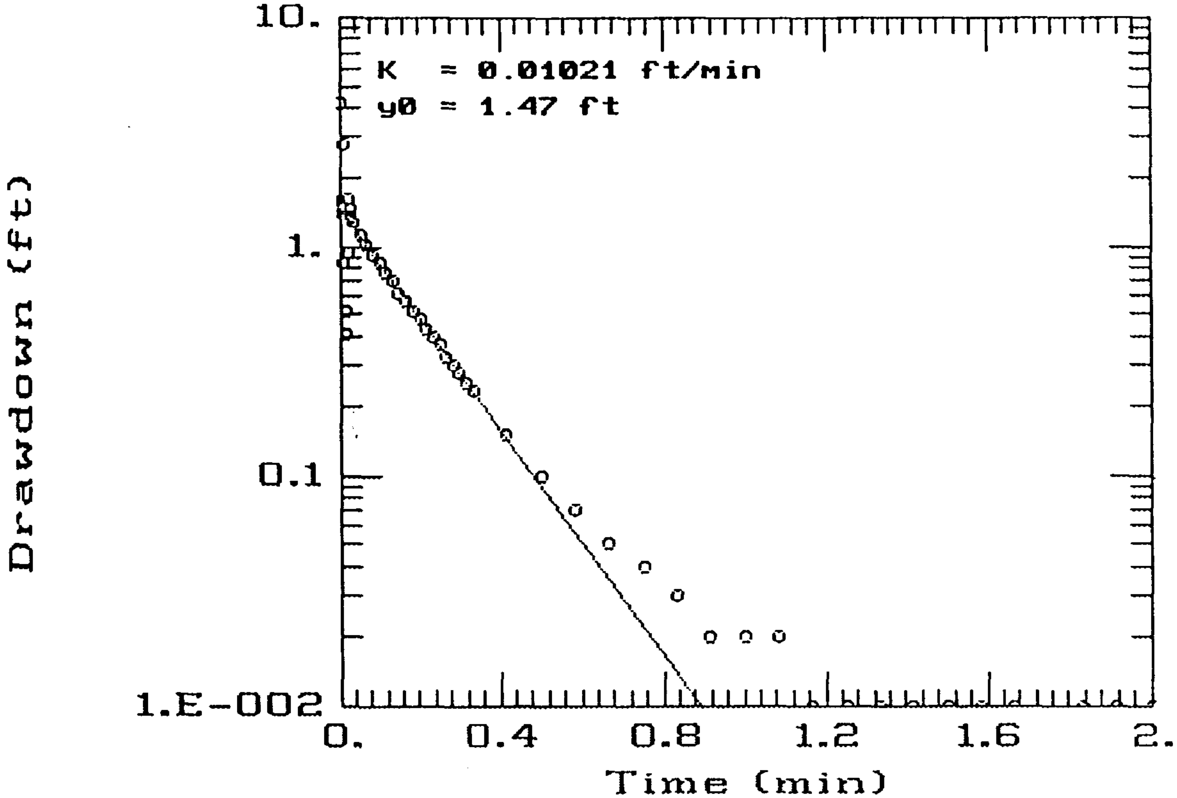


AQTESOLV

GERAGHTY & MILLER, INC.

Modeling Group

WCP RI/FS MW-5D SLUG IN TEST 1



AQTESOLV

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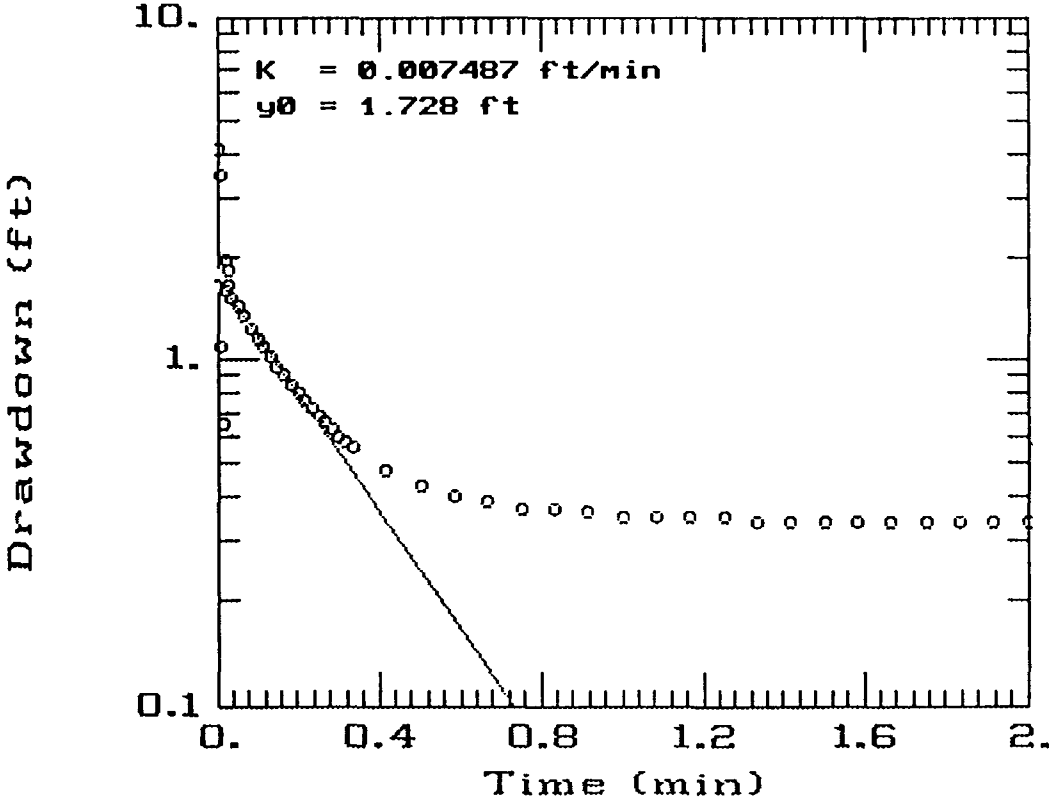
Modeling Group

WCP RI/FS MW-5D SLUG IN TEST 2



AQTESOLV

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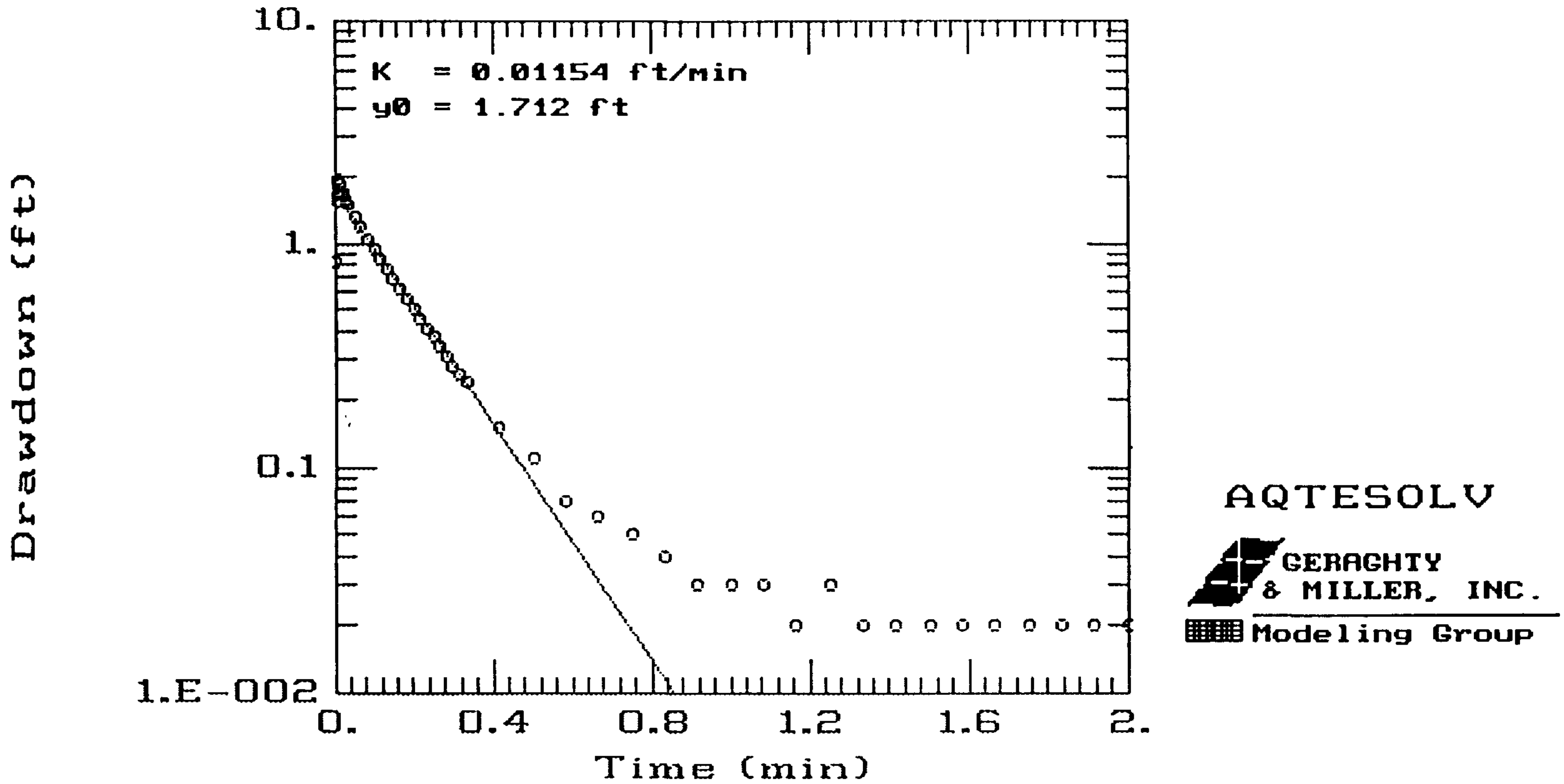
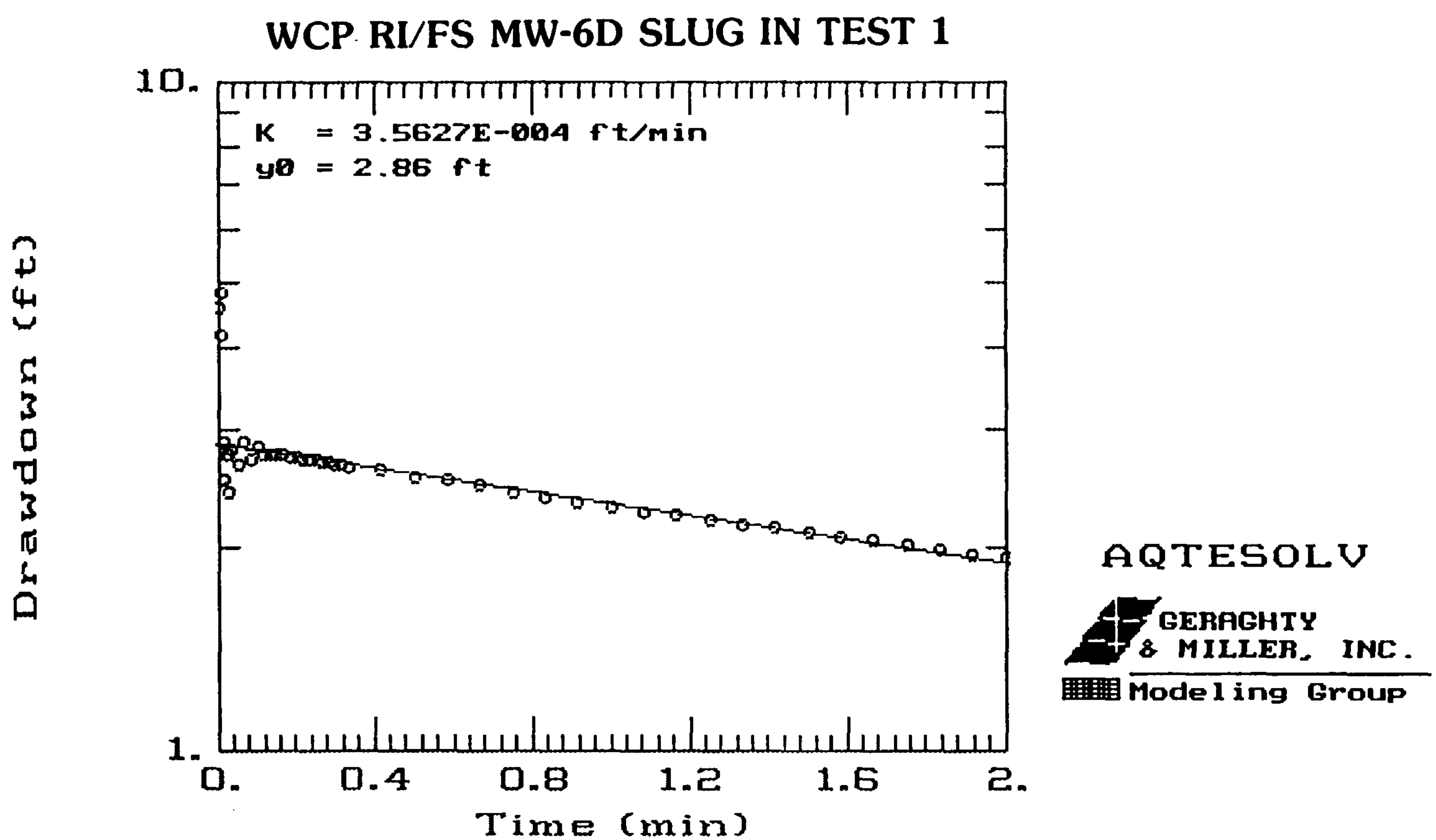
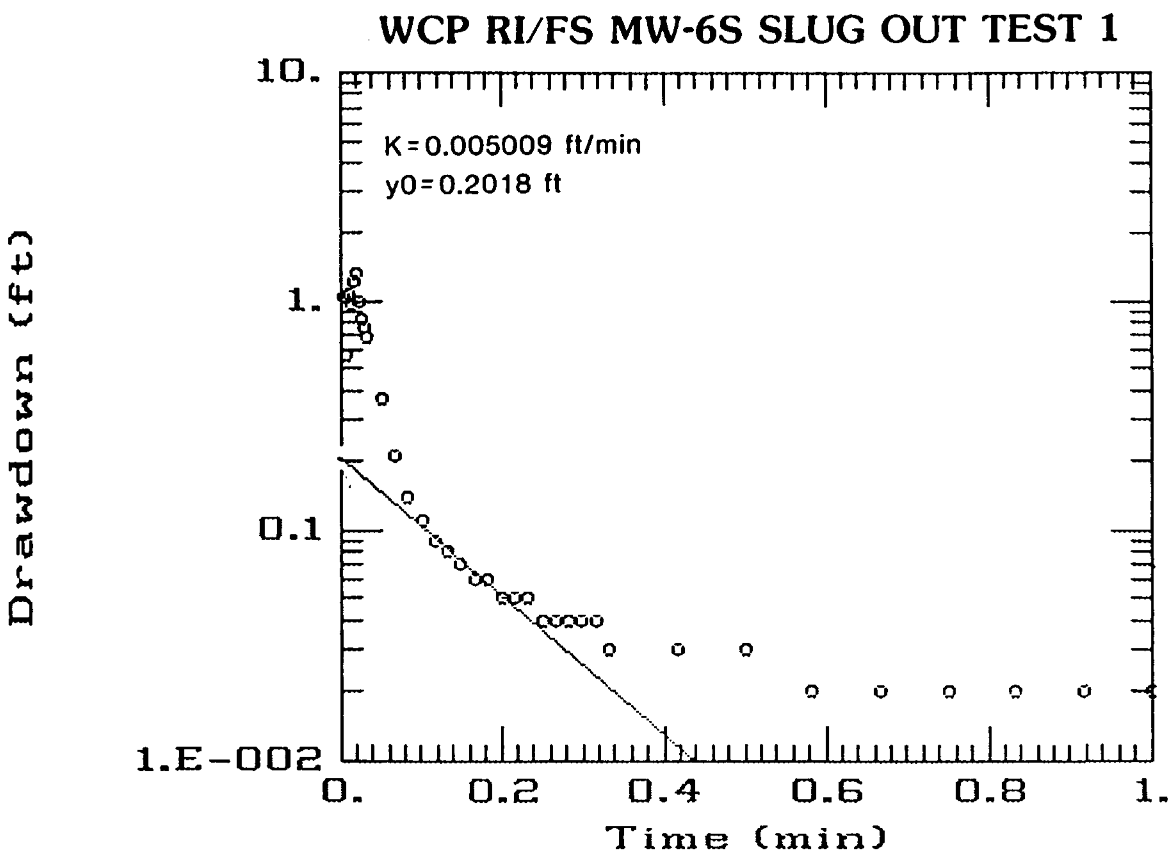
Modeling Group

WCP RI/FS MW-5D SLUG OUT TEST 1




WCP RI/FS MW-6D SLUG IN TEST 1
K = 3.5627E-004 ft/min
y0 = 2.86 ft
10.
1.
Drawdown (ft)
0.
0.4
0.8
1.2
1.6
2.
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group

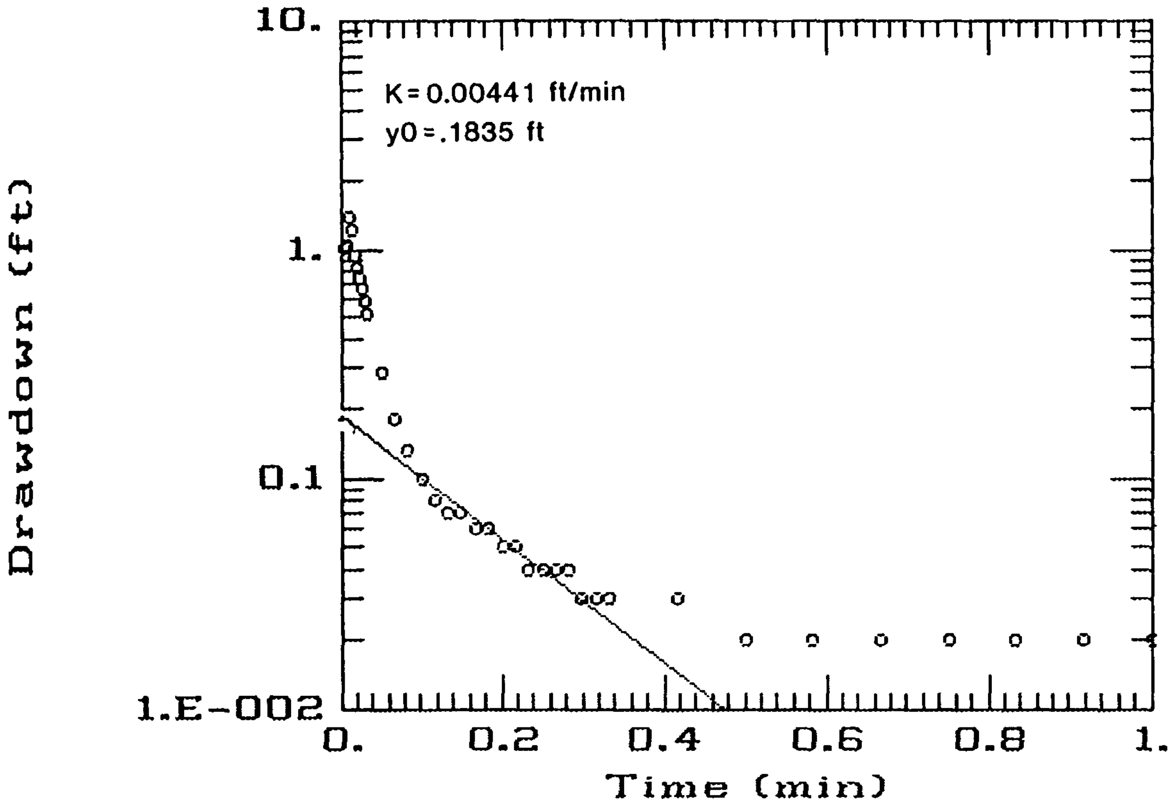


AQTESOLV

GERAGHTY & MILLER, INC.

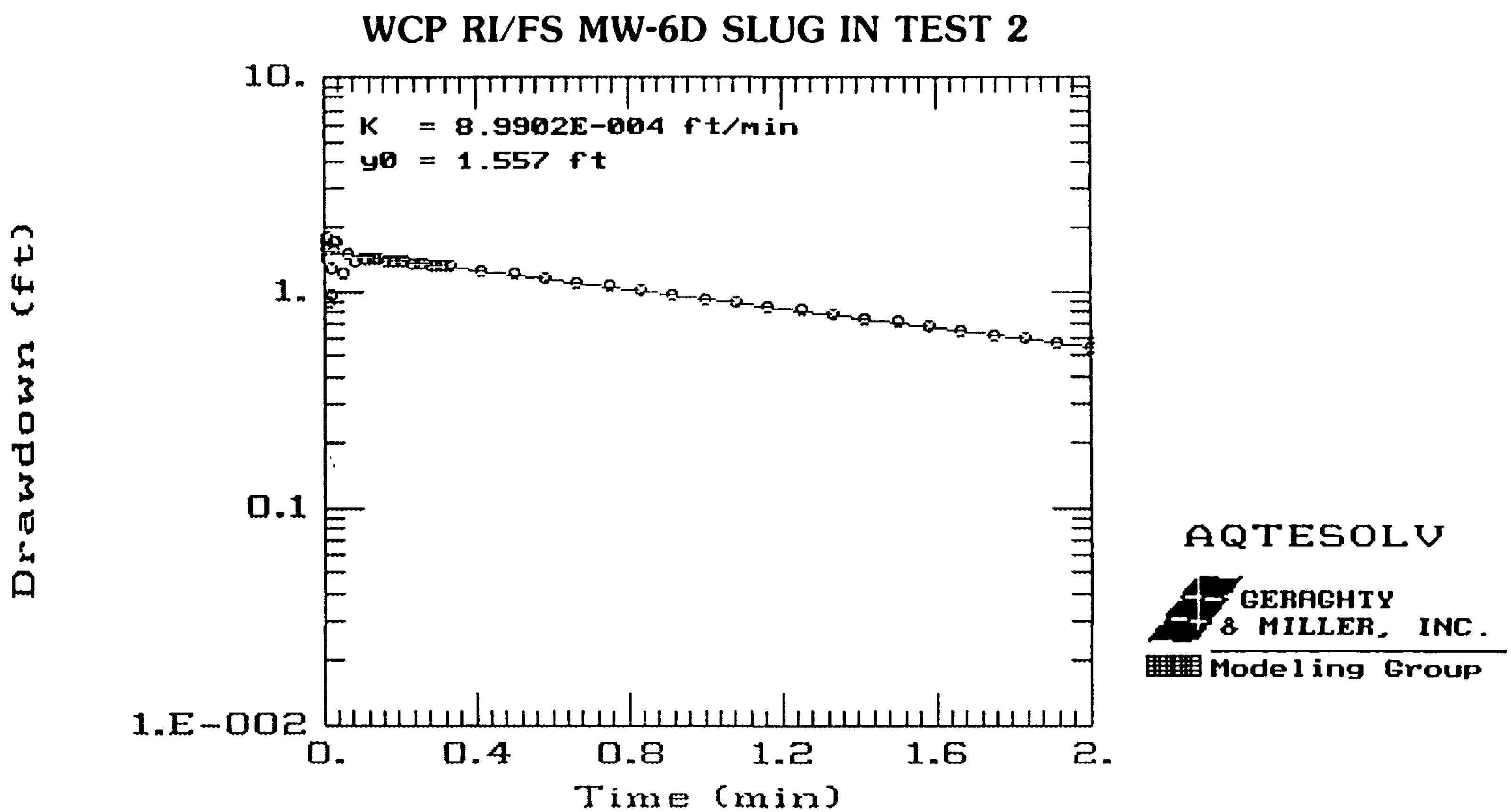
Modeling Group

WCP RI/FS MW-6S SLUG OUT TEST 2

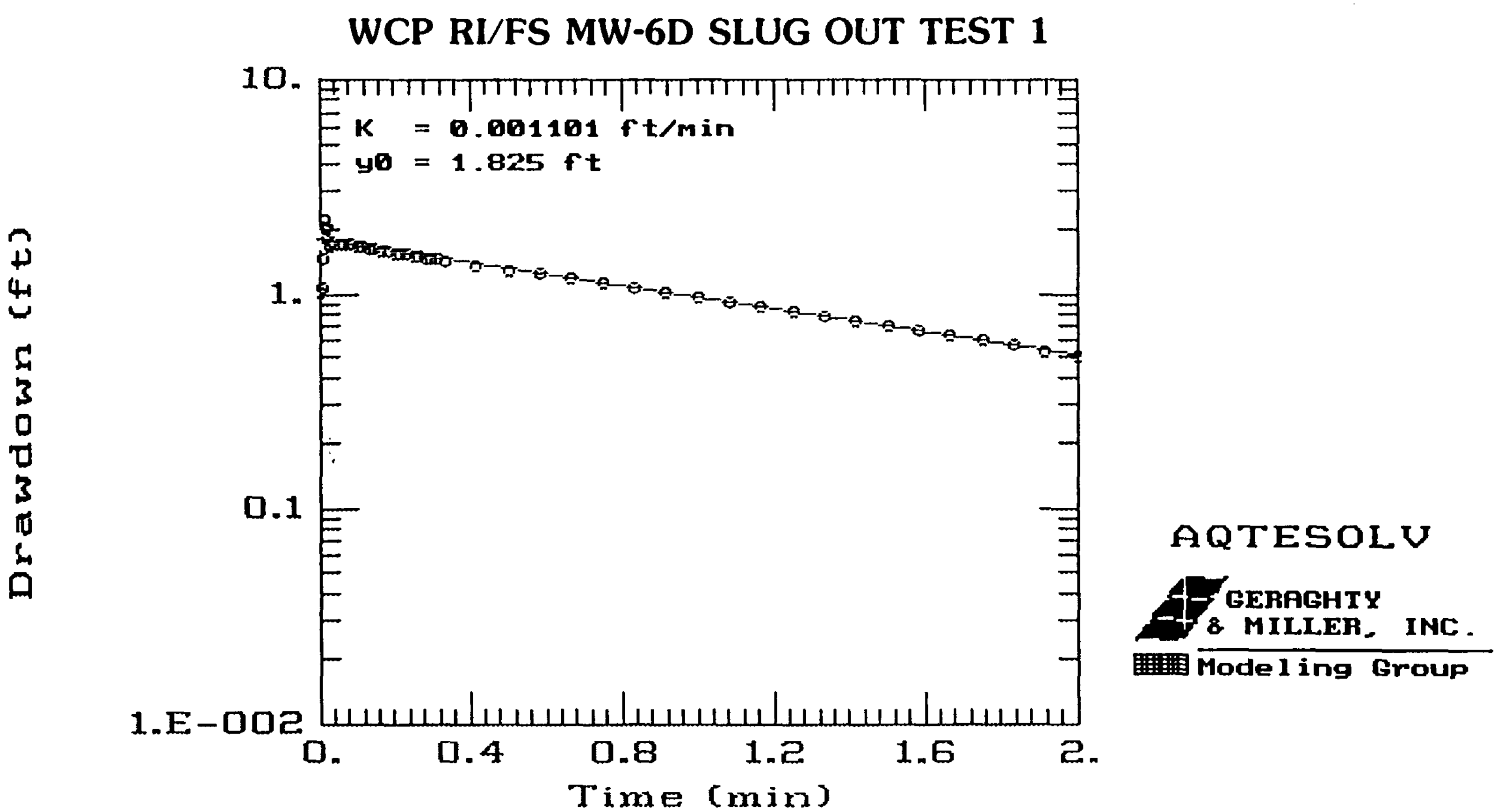


AQTESOLV

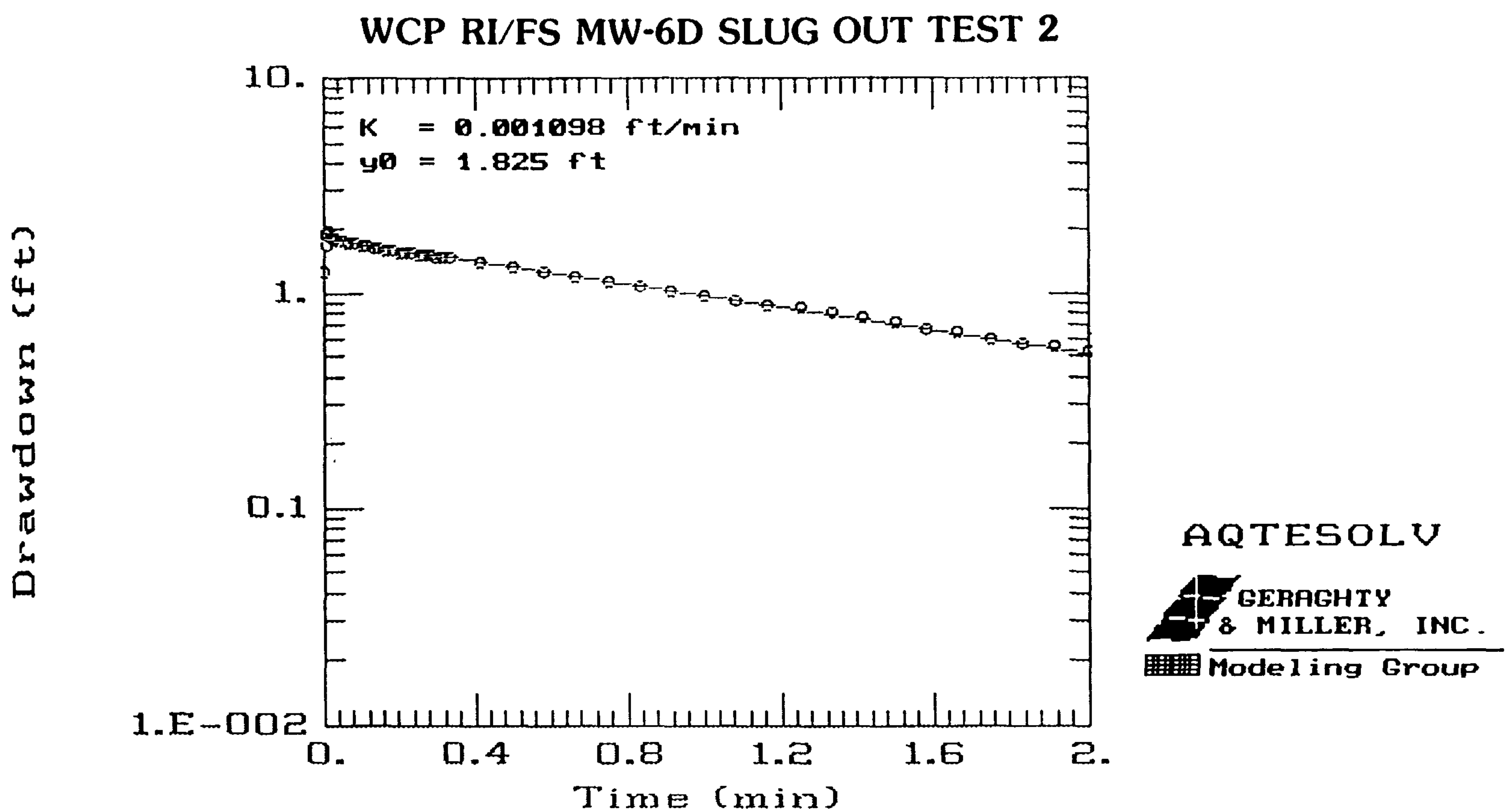
GERAGHTY & MILLER, INC.
Modeling Group



WCP RI/FS MW-6D SLUG IN TEST 2
K = 8.9902E-004 ft/min
y0 = 1.557 ft
10.
1.
0.1
1.E-002
0.
0.4
0.8
1.2
1.6
2.
Time (min)
Drawdown (ft)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group



WCP RI/FS MW-6D SLUG OUT TEST 1
K = 0.001101 ft/min
y0 = 1.825 ft
10.
1.
0.1
1.E-002
0.
0.4
0.8
1.2
1.6
2.
Time (min)
Drawdown (ft)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group



WCP RI/FS MW-6D SLUG OUT TEST 2
K = 0.001098 ft/min
y0 = 1.825 ft
10.
1.
0.1
1.E-002
0.
0.4
0.8
1.2
1.6
2.
Time (min)
Drawdown (ft)
AQTESOLV
GERAGHTY
& MILLER, INC.
Modeling Group

Appendix H

Phase I Groundwater Sampling Field Log Data Sheets

WATER LEVEL DATA SHEET

PROJECT NAME WAKEGAN / WCP RI/FS

SAMPLERS JEG
DATE 4/9/92
PAGE ____ OF ____

WELL NUMBER	MEASURING POINT ELEVATION	WATER LEVEL DEPTH	TOTAL WELL DEPTH	WATER LEVEL ELEVATION	COMMENTS
P101	588.14	5.87	15.22	582.27	
P102	588.52	5.59	15.09	582.93	
P103	589.44	7.06	15.42	582.38	
P104	589.07	6.34	15.06	582.73	
MW3D	588.23	5.69	30.84	582.54	
MW3S	588.24	5.65	15.04	582.59	
MW4D	589.06	6.65	34.34	582.41	
MW4S	589.17	6.68	15.45	582.49	
MW5D	588.47	7.94	28.62	580.53	
MW5S	587.89	7.34	16.28	580.55	
MW6D	588.51	7.84	29.53	580.67	
MW6S	588.45	7.71	16.75	580.74	
MW1D	587.62	5.88	29.75	581.74	
MW1S	587.76	6.01	19.75	581.75	
Harbor	584.65				

WATER LEVEL DATA SHEET

PROJECT NAME WAKEGAN / WCP RI/FS

SAMPLERS E. Gabrielson
DATE 4/7/92
PAGE ____ OF ____

WELL NUMBER	MEASURING POINT ELEVATION	WATER LEVEL DEPTH	TOTAL WELL DEPTH	WATER LEVEL ELEVATION	COMMENTS
P101	588.14	5.84	15.22	582.30	
P102	588.52	5.50	15.09	583.02	
P103	589.44	6.99	15.42	582.45	
P104	589.07	6.27	15.06	582.80	
MW3D	588.23	5.59	30.84	582.64	
MW3S	588.24	5.54	15.04	582.70	
MW4D	589.06	6.54	34.34	582.52	
MW4S	589.17	6.62	15.45	582.55	
MW5D	588.47	7.93	28.62	580.54	
MW5S	587.89	7.32	16.28	580.57	
MW6D	588.51	7.81	29.53	580.70	
MW6S	588.45	7.70	16.75	580.75	
MW1D	587.62	5.84	29.75	581.78	
MW1S	587.76	5.97	19.75	581.79	
Harbor	584.65				

FIELD LOG COVER SHEET

WATER SAMPLING

Client: WAKEGAN / WCP RI/FS Project Number 13 / 49 - 003JSL 3 /

Samplers: JEG KSJ Sampling Period: 4 / 7 / 92
4 / 8 / 92
4 / 9 / 92
/ /

Weather:

Date	Temperature	Wind Speed	Wind Direction	Cloud Cover
4 / 7 / 92	45 oF	5-10 mph	W	40 %
4 / 8 / 92	50 oF	10-15 mph	SE	10 %
4 / 9 / 92	oF	mph		
/ /	oF	mph		

Containers received from: Pace Braun Enseco CH2M Hill EDI

Samples shipped for analysis to: Pace Braun Enseco CH2M Hill EDI

Samples dropped off at: Pace Braun

Water blank received from: Pace Braun Enseco CH2M Hill EDI

Type of blank: Trip / Field Field blank is: air / water

Mask # 1 collected at station # MW4D-1 Mask # 2 collected at station # MW6S-1
MS/MSD - MW5S-1

Name and affiliation of others present: pete Lynch PRC

Comments:

Water Levels were taken 4/7/92 and 4/9/92.

FIELD DATA REPORT

PROJECT NAME WAKEGAN WCP RI/FS

PROJECT NUMBER 1 3 / 4 9 - 0 0 3 7 5 W 3 1 1

SAMPLER E. Gabritlson KSJ

SAMPLING LOCATION	SAMPLING DATE MONTH DAY YEAR	TEMP °C	CONDUCTIVITY @ 25°C	pH	STATIC	ELEVATION
MW 3 S	4/7/92	11.0	585	7.4	15.54	
MW 3 D		13.0	10200	9.4	5.59	
MW 4 S		10.0	800	8.0	6.62	
MW 4D		13.0	12100	9.2	6.54	
MW 5 S	4/8/92	9.0	475	7.4	7.32	
MW 5 D		11.0	4400	8.2	7.93	
MW 6 S		11.0	1100	7.5	7.70	
MW 6 D		11.0	13500	7.5	7.81	
MW 1 S	4/9/92	11.0	1200	7.2	5.97	
MW 1D		12.0	6500	8.6	5.84	
Carbon - inf		11.0	6000	8.3	—	
Carbon - eff		9.0	9000	8.2	—	

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW35-1

Client WCP RI/FS Project No. 23-49-003 JSC31

Location: ______ Date: 4/7/92 Sample Time: 1520

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N		1. 1502	12.0	450		7.3	
Casing Dia: (in.)	2"	2. 1503 30	11.0	445		7.4	
Total Depth (ft.)	15	3. 1504 30	11.0	440		7.4	
Static Depth (ft.)	5.54	4. 1505	11.0	440	585	7.4	
Water Depth:	10	5.					
Well Vol. (gal.)	1.5	6.					
Purge Method:	Cnt	7.					
Samp. Method:	Bailer	Appearance: Brown					
Start Time:	1458	Odor: yes					
Stop Time:	1505	Comments: FB-1 found					
Duration: (min.)	7						
Rate, gpm:	1.5						
Volume Purged:	10.5						

Samplers: JEG KSJ Others Present:

gen 3 VOC ___ COD ___ TOC ___ semi-volatile 2 f. metal 1 t. metal ___

nitro ___ cyanide 1 oil & grease ___ 200 ml filter ___ 500 ml filter ___

others ___

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW30-1

Client: WCP RI/FS　　Project No. 13-49-003J S431

Location: ______　　Date: 4/7/92　　Sample Time: 1536

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock Y N		1. 1510	13.0	8000		9.4	
Casing Dia: (in.)	2	2. 1512	13.0	8000		9.4	
Total Depth (ft.)	31	3. 1530	13.0	8000	10200	9.4	
Static Depth (ft.)	5.59	4.					
Water Depth:	25.5	5.					
Well Vol. (gal.)	4	6.					
Purge Method:	Cent	7.					
Samp. Method:	Bailer	Appearance: light brown, milky white residue					
Start Time:	1507	Odor: yes					
Stop Time:	1514	Comments:					
Duration: (min.)	7						
Rate, gpm:	3						
Volume Purged:	21						

Samplers: ______　　Others Present: ______

gen ____ VOC 3 ____ COD ____ TOC ____ semi-volatile 2 f. metal ____ t. metal ____

nitro ____ cyanide 1 ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ______

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW4S-1

Client WCP RI/FS　　Project No. 13-49-003 5C31

Location:　　Date: 4/7/92　　Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N		1. 4.5/GAL	10	600		8.0	
Casing Dia: (in.)	2"	2. 6.0/GAL	10	600		8.0	
Total Depth (ft.)	15.5	3. 7.5/GAL	10	600	800	8.0	
Static Depth (ft.)	6.62	4.					
Water Depth:	9	5.					
Well Vol. (gal.)	1.5	6.					
Purge Method:	cent	7.					
Samp. Method:	Bailer	Appearance: clear					
Start Time:	1639	Odor: NO					
Stop Time:	1643	Comments:					
Duration: (min.)	4						
Rate, gpm:	2						
Volume Purged:	8						

Samplers: JEG KSJ　　Others Present:

gen ____ VOC 3 COD ____ TOC ____ semi-volatile 2 f. metal 1 t. metal ____

nitro ____ cyanide 1 oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW40-1

Client: WCP RI/FS Project No. 13-49-003-JS-43

Location: ______ Date: 4/7/92 Sample Time: 1720

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N		1. 1651	12.0	8500		9.16	
Casing Dia: (in.)	2"	2. 1653	13.	9500		9.19	
Total Depth (ft.)	34.5	3. 1655	13	9500	12100	9.19	
Static Depth (ft.)	6.54	4.					
Water Depth:	28	5.					
Well Vol. (gal.)	4.5	6.					
Purge Method:	cent	7.					
Samp. Method:	Bailer	Appearance: orange/white					
Start Time:	1645	Odor: yes					
Stop Time:	1655	Comments: M-1					
Duration: (min.)	10						
Rate, gpm:	2						
Volume Purged:	22.5						

Samplers: JEG KSJ Others Present:

gen ____ VOC 6 COD ____ TOC ____ semi-volatile 4 f. metal 2 t. metal ____

nitro ____ cyanide 2 oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW5S-1

Client: WCP RI/FS Project No. 13-49-003 JSC 311

Location: ______ Date: 4/8/92 Sample Time: 1220 → 1259

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: (Y) N	✓	1. 4.5	9.0	350		7.5	
Casing Dia: (in.)	2"	2. 6.0	9.0	340		7.4	
Total Depth (ft.)	16	3. 7.5	9.0	340		7.4	
Static Depth (ft.)	7.32	4. 9.0	9.0	340	475	7.4	
Water Depth:	8.6	5.					
Well Vol. (gal.)	1.5	6.					
Purge Method:	Centr.	7.					
Samp. Method:	bailer	Appearance:					
Start Time:	1207	Odor:					
Stop Time:	1214	Comments: MS/MSD					
Duration: (min.)	7						
Rate, gpm:	1	10% clouds, 50°F, SE @ 10-15 mph					
Volume Purged:	7.5	YSI meters. conductivity - redline ok ORION pH - 7.00 : 10.00					

Samplers: KSJ JEG Others Present: PEK LYNCH

gen ____ VOC 9 COD ____ TOC ____ semi-volatile 6 f. metal 3 t. metal ____

nitro ____ cyanide 3 oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW5D-1

Client WCP RI/FS Project No. 23/47-003 543

Location: Date: 4/18/92 Sample Time: 1320

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N		1. 10.5	11.0	2900		8.2	
Casing Dia: (in.)	2"	2. 14.0	11.0	3300		8.2	
Total Depth (ft.)	28.5	3. 17.5	11.0	3300		8.2	
Static Depth (ft.)	7.93	4. 21.	11.0	3300	4400	8.2	
Water Depth:	20.5	5.					
Well Vol. (gal.)	3.5	6.					
Purge Method:	Cent	7.					
Samp. Method:	Bailer	Appearance: orange					
Start Time:	1303	Odor: yes					
Stop Time:	1312	Comments:					
Duration: (min.)	9						
Rate, gpm:	2						
Volume Purged:	17.5						

Samplers: KSJ JEG Others Present: Pete LYNCH

gen ____ VOC 3 COD ____ TOC ____ semi-volatile 2 f. metal 1 t. metal ____

nitro ____ cyanide 1 oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Appendix I

Hydrogeologic Model Development

CHAIN OF CUSTODY

BARR ENGINEERING CO.
7803 GLENROY ROAD
MINNEAPOLIS, MN 55439

PROJECT NUMBER № 01545
13/49-003 JSL 31

NO:

PROJECT MANAGER: JSL

PROJECT CONTACT: SDI

LABORATORY: CH2MHill

REMARKS/ANALYSIS REQUIRED: Level 3 QA QC

See List

SAMPLE IDENTIFICATION	COLLECTION DATE	COLLECTION TIME	GRAB	COMP.	BLANK	VOLATILE ORGANIC	SEMIVOLATILE ORGANIC	FILTERED METALS	UNFILTERED METALS	GENERAL	CYANIDE	NUTRIENTS	OIL AND GREASE	TOC	SULFIDE	DIOXIN	TOTAL NO. OF CONTAINERS
MW55-1	4/8/92		X			3	2										5
MW55-1/MS			X			3	2										5
MW55-1/MSD			X			3	2										5
MW65-1			X			3											3
MW60-1			X			3											3
MW50-1			X			3											3
M-2			X			3											3
FB-2					X	3											3

SAMPLED BY: Eric Garrickson KSJ	RELINQUISHED BY:	DATE 4/8/92	TIME	RECEIVED BY LAB:	DATE	TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
REMARKS:	SAMPLES SHIPPED VIA ☐ AIR FREIGHT ☐ FED. EXP. ☐ SAMPLER ☐ OTHER			AIR BILL NUMBER:		

DISTRIBUTION: WHITE-ORIGINAL ACCOMPANIES SHIPMENT TO LAB, RETURNS TO BARR WITH RESULTS; YELLOW-LAB COPY; PINK-LAB COORDINATOR; GOLD-FIELD COPY

CHAIN OF CUSTODY

BARR ENGINEERING CO.

7803 GLENROY ROAD

MINNEAPOLIS, MN 55439

PROJECT NUMBER № 01543

13/49-003 JSL 31

NO:

CONTAINER TYPE AND NUMBER

PROJECT MANAGER: JSL

PROJECT CONTACT: SDI

LABORATORY: Ch2mHill

REMARKS/ ANALYSIS REQUIRED: Level 3 QA/QC

SAMPLE IDENTIFICATION	COLLECTION DATE	COLLECTION TIME	GRAB	COMP.	BLANK	VOLATILE ORGANIC	SEMIVOLATILE ORGANIC	FILTERED METALS	UNFILTERED METALS	GENERAL	CYANIDE	NUTRIENTS	OIL AND GREASE	TOC	SULFIDE	DIOXIN	TOTAL NO. OF CONTAINERS	REMARKS
MW6S-1	4/8/92		X				2	1			1						4	
MW5D-1			X								1						1	See
MW6D-1			X								1						1	List
MW5S-1/MSD			X					1			1						2	
MW5S-1			X					1			1						2	
MW5S-1/MS			X					1			1						2	
M-2			X					1			1						2	

SAMPLED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
Eric Gabrielson KSJ	JSG	4/8/92				
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME

REMARKS:

SAMPLES SHIPPED VIA ☐ AIR FREIGHT ☐ FED. EXP. ☐ SAMPLER ☐ OTHER

AIR BILL NUMBER:

DISTRIBUTION: WHITE-ORIGINAL ACCOMPANIES SHIPMENT TO LAB, RETURNS TO BARR WITH RESULTS; YELLOW-LAB COPY; PINK-LAB COORDINATOR; GOLD-FIELD COPY

CHAIN OF CUSTODY

BARR ENGINEERING CO.
7803 GLENROY ROAD
MINNEAPOLIS, MN 55439

PROJECT NUMBER № 01544
13149-003 JSL31

NO:

PROJECT MANAGER: JSC

PROJECT CONTACT: SDT

LABORATORY: CH2M Hill

REMARKS/ ANALYSIS REQUIRED: Level 3 QA/QC

SAMPLE IDENTIFICATION	COLLECTION DATE	COLLECTION TIME	GRAB	COMP.	BLANK	VOLATILE ORGANIC	SEMIVOLATILE ORGANIC	FILTERED METALS	UNFILTERED METALS	GENERAL	CYANIDE	NUTRIENTS	OIL AND GREASE	TOC	SULFIDE	DIOXIN	TOTAL NO. OF CONTAINERS	REMARKS
M-2	4/8/92		X				2										2	See List
MW50-1	|		X				2	1									3	
MW6D-1	|		X				2	1									3	

SAMPLED BY: Eric Gabrielson KSJ	RELINQUISHED BY: [signature]	DATE 4/8/92	TIME	RECEIVED BY LAB:	DATE	TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
REMARKS:	SAMPLES SHIPPED VIA ☐ AIR FREIGHT ☐ FED. EXP. ☐ SAMPLER ☐ OTHER			AIR BILL NUMBER:		

DISTRIBUTION: WHITE-ORIGINAL ACCOMPANIES SHIPMENT TO LAB, RETURNS TO BARR WITH RESULTS; YELLOW-LAB COPY; PINK-LAB COORDINATOR; GOLD-FIELD COPY

CHAIN OF CUSTODY

BARR ENGINEERING CO.
7803 GLENROY ROAD
MINNEAPOLIS, MN 55439

PROJECT NUMBER № 01542
13/49-003T

NO:

PROJECT MANAGER: JSL

PROJECT CONTACT: SDI

LABORATORY: CH2MHill

REMARKS/ ANALYSIS REQUIRED: Level 3 QA/QC

See List

SAMPLE IDENTIFICATION	COLLECTION DATE	COLLECTION TIME	GRAB	COMP.	BLANK	VOLATILE ORGANIC	SEMIVOLATILE ORGANIC	FILTERED METALS	UNFILTERED METALS	GENERAL	CYANIDE	NUTRIENTS	OIL AND GREASE	TOC	SULFIDE	DIOXIN	TOTAL NO. OF CONTAINERS
M-1	4/7/92		X				2										2
MW4D-1	↓		X				2										2
MW4S-1	↓		X				2										2

SAMPLED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
REMARKS:	SAMPLES SHIPPED VIA ☐ AIR FREIGHT ☐ FED. EXP. ☐ SAMPLER ☐ OTHER			AIR BILL NUMBER:		

DISTRIBUTION: WHITE-ORIGINAL ACCOMPANIES SHIPMENT TO LAB, RETURNS TO BARR WITH RESULTS; YELLOW-LAB COPY; PINK-LAB COORDINATOR; GOLD-FIELD COPY

CHAIN OF CUSTODY
BARR ENGINEERING CO.
7803 GLENROY ROAD
MINNEAPOLIS, MN 55439

PROJECT NUMBER No. 01541
13/49-003 JSL 31

NO:

PROJECT MANAGER: JSL
PROJECT CONTACT: SDI
LABORATORY: CH_2M Hill
REMARKS/ ANALYSIS REQUIRED: Level 3 QA/QC

CONTAINER TYPE AND NUMBER

SAMPLE IDENTIFICATION	COLLECTION DATE	COLLECTION TIME	GRAB	COMP.	BLANK	VOLATILE ORGANIC	SEMIVOLATILE ORGANIC	FILTERED METALS	UNFILTERED METALS	GENERAL	CYANIDE	NUTRIENTS	OIL AND GREASE	TOC	SULFIDE	DIOXIN										TOTAL NO. OF CONTAINERS
MW3D-1	4/7/92		X					1			1															2
MW3S-1			X					1			1															2
MW4D-1			X					1			1															2
MW4S-1			X					1			1															2
FB-1					X			1			1															2
M-1			X					1			1															2

SAMPLED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
Eric Cabrickon KSS	EC [illegible]	4/7/92				
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME

REMARKS:

SAMPLES SHIPPED VIA
☐ AIR FREIGHT ☐ FED. EXP. ☒ SAMPLER
☐ OTHER

AIR BILL NUMBER:

DISTRIBUTION: WHITE-ORIGINAL ACCOMPANIES SHIPMENT TO LAB, RETURNS TO BARR WITH RESULTS; YELLOW-LAB COPY; PINK-LAB COORDINATOR; GOLD-FIELD COPY

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BARR ENGINEERING CO.
7803 GLENROY ROAD
MINNEAPOLIS, MN 55439

PROJECT NUMBER 13/49-003 JSL 311 No. 01547

NO:

PROJECT MANAGER: JSL

PROJECT CONTACT: SDI

LABORATORY: CH2M Hill

REMARKS/ ANALYSIS REQUIRED: Level 3 QA/QC

SAMPLE IDENTIFICATION	COLLECTION DATE	COLLECTION TIME	GRAB	COMP.	BLANK	VOLATILE ORGANIC	SEMIVOLATILE ORGANIC	FILTERED METALS	UNFILTERED METALS	GENERAL	CYANIDE	NUTRIENTS	OIL AND GREASE	TOC	SULFIDE	DIOXIN	TOTAL NO. OF CONTAINERS	REMARKS
MW15-1	4/9/92		X			3											3	
MW10-1			X			3	2										5	See
φCF eFF				X		3	2	1									6	
CF iN6				X		3		1									4	List
FB-3					X	3	2										5	

SAMPLED BY: Eric Gabrielson KSJ	RELINQUISHED BY: [signature]	DATE 4/9/92	TIME	RECEIVED BY LAB:	DATE / TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE / TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE / TIME
REMARKS:	SAMPLES SHIPPED VIA ☐ AIR FREIGHT ☐ FED. EXP. ☐ SAMPLER ☐ OTHER			AIR BILL NUMBER:	

DISTRIBUTION: WHITE-ORIGINAL ACCOMPANIES SHIPMENT TO LAB, RETURNS TO BARR WITH RESULTS; YELLOW-LAB COPY; PINK-LAB COORDINATOR; GOLD-FIELD COPY

CHAIN OF CUSTODY

BARR ENGINEERING CO.
7803 GLENROY ROAD
MINNEAPOLIS, MN 55439

PROJECT NUMBER: 13149-003 JSL31

NO:

PROJECT MANAGER: JSL

PROJECT CONTACT: SDI

LABORATORY: CH2M Hill

REMARKS/ ANALYSIS REQUIRED: Level 3 QA/QC

SAMPLE IDENTIFICATION	COLLECTION DATE	COLLECTION TIME	GRAB	COMP.	BLANK	VOLATILE ORGANIC	SEMIVOLATILE ORGANIC	FILTERED METALS	UNFILTERED METALS	GENERAL	CYANIDE	NUTRIENTS	OIL AND GREASE	TOC	SULFIDE	DIOXIN	TOTAL NO. OF CONTAINERS	REMARKS
MW3S-1	4/7/92		X			3	2										5	See List
MW3D-1			X			3	2										5	
FB-1					X	3	2										5	
MW4S-1			X			3											3	
MW4D-1			X			3											3	
M-1			X			3											3	
TB-1					X	3											3	

SAMPLED BY: Eric Gabrielson EGJ	RELINQUISHED BY: [signature]	DATE 4/7/92	TIME	RECEIVED BY LAB:	DATE	TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME
RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY LAB:	DATE	TIME

REMARKS:

SAMPLES SHIPPED VIA ☐ AIR FREIGHT ☐ FED. EXP. ☒ SAMPLER ☐ OTHER

AIR BILL NUMBER:

DISTRIBUTION: WHITE-ORIGINAL ACCOMPANIES SHIPMENT TO LAB. RETURNS TO BARR WITH RESULTS; YELLOW-LAB COPY; PINK-LAB COORDINATOR; GOLD-FIELD COPY

PROJECT: 13149-003[redacted]31

SAMPLING REQUEST FORM

SAMPLE ORDER AND LOCATION	STABILIZE	PREVIOUS VOLUME			40ML VIAL	40ML VIAL W/HCL		125ML AMBER W/TEFLON	500ML AMBER W/TEFLON	1L AMBER W/TEFLON	2L AMBER W/TEFLON			250ML PLASTIC	500ML PLASTIC	1L PLASTIC		250ML PLASTIC W/HNO3	500ML PLASTIC W/HNO3	1L PLASTIC W/HNO3		250ML PLASTIC W/H2SO4	500ML PLASTIC W/H2SO4	1L PLASTIC W/H2SO4		1500ML GLASS W/H2SO4		1L PLASTIC W/NAOH + ASCORBIC ACID								METHANE	FLOW		EH	APPEARANCE		TEMPERATURE	CONDUCTIVITY	PH	WATER LEVEL
1. P101	✓																																												X
2. P102	✓																																												X
3. P103	✓																																												X
4. P104	✓																																												X
5. Harbor	✓																																												X
~~6.~~ MW3S	X					3					2									1								1												X		X	X	X	X
~~7.~~ MW3D	X					3					2									1								1												X		X	X	X	X
~~8.~~ MW4S	X					3					2									1								1												X		X	X	X	X
~~9.~~ MW4D	X					3					2									1								1												X		X	X	X	X
~~10.~~ MW5S	X					3					2									1								1												X		X	X	X	X
~~11.~~ MW5D	X					3					2									1								1												X		X	X	X	X
~~12.~~ MW6S	X					3					2									1								1												X		X	X	X	X
(1) LABORATORY	F					C					C								C	C								C												F		F	F	F	F

(1) LABORATORY CODES: A = ASPEN P = PACE E = ENSECO F = FIELD/BARR C = CH2M HILL B = BRAUN D = EDI

BARR CONTACT ______ SPLIT ______ SCHEDULED DATE April 6-10, '92 COMPLETION DATE ______

SPECIAL INSTRUCTIONS CLP procedures

PROJECT MGR. JSL / KAF SAMPLER ______ FORM COMPLETED BY: KAF DATE: 4-2-92

YELLOW- LAB COORDINATOR; PINK- PROJECT MANAGER

CHAIN OF CUSTODY
BARR ENGINEERING CO.
7803 GLENROY ROAD
MINNEAPOLIS, MN 55439

PROJECT NUMBER № 01546
13/49-003 JSL 31

NO:

PROJECT MANAGER: JSL

PROJECT CONTACT: SDI

LABORATORY: CH2M Hill

REMARKS/ ANALYSIS REQUIRED: Level 3 QACQ

CONTAINER TYPE AND NUMBER

SAMPLE IDENTIFICATION	COLLECTION DATE	COLLECTION TIME	GRAB	COMP.	BLANK	VOLATILE ORGANIC	SEMIVOLATILE ORGANIC	FILTERED METALS	UNFILTERED METALS	GENERAL	CYANIDE	NUTRIENTS	OIL AND GREASE	TOC	SULFIDE	DIOXIN	TOTAL NO. OF CONTAINERS	REMARKS
MW1S-1	4/9/92		X				2	1			1						4	& See List
CF-inf 1			X				2				1						3	
MW1D-1			X					1			1						2	
CF-eFF-1			X					1			~~1~~						1	
FB-3					X			1			1						2	

SAMPLED BY: Eric Gabrielson KSJ

RELINQUISHED BY: [signature] DATE 4/11/92 TIME

RECEIVED BY LAB: DATE TIME

RECEIVED BY:

RELINQUISHED BY: DATE TIME

RECEIVED BY LAB: DATE TIME

RECEIVED BY:

RELINQUISHED BY: DATE TIME

RECEIVED BY LAB: DATE TIME

REMARKS:

SAMPLES SHIPPED VIA
☐ AIR FREIGHT ☐ FED. EXP. ☐ SAMPLER
☐ OTHER

AIR BILL NUMBER:

DISTRIBUTION: WHITE-ORIGINAL ACCOMPANIES SHIPMEN[T TO] LAB, RETURNS TO BARR WITH RESULTS; [YE]LLOW-LAB COPY; PINK-LAB COORDINATOR; GOLD-FIELD COPY

GROUNDWATER SAMPLING AND ANALYSIS REQUEST

PROJECT NUMBER 13/49-C03 JSL 31

PROJECT NAME WCP RI/FS

PROJECT MANAGER/DESIGNATE JSL / KAF

PROJECT TYPE:
- MONITORING ☐
- RI ☒
- OTHER ☐

PROJECT DESCRIPTION/SITE HISTORY Phase I RI/FS / former coal gasification site

SITE LOCATION Waukegan, Illinois

QAPP YES ☒ NO ☐

TURN AROUND TIME normal

SITE SAFETY PLAN YES ☒ NO ☐

DATE OF SCHEDULED SAMPLING April 6-10, 1992

AGENCY NOTIFICATION/SPLIT YES ☐ NO ☒

AGENCY CONTACT ____

PHONE NUMBER ____

SAMPLING LOCATION	SAMPLING ORDER	WELL DIAMETER	TOTAL DEPTH	DEPTH TO WATER	ANALYSES REQUESTED
P101					
P102					water level with tape and chalk
P103					total well depth
P104					
Harbor					
MW3S					total well depth
MW3D					pH, conductivity, temperature
MW4S					water level
MW4D					CLP-RAS TCL Volatiles
MW5S					CLP-RAS TCL Semivolatiles
MW5D					CLP-RAS TCL Pesticides/PCBs
MW6S					CLP-RAS TAL Metals/Cyanide
MW6D					
MW1S					
MW1D					
carbon filter influent					
carbon filter effluent					

QC REQUIRED STANDARD ☐

SPECIAL NEEDS CLP procedures

DATA MANAGEMENT NEEDS data validation and entry - CLP protocol

LABORATORY PREFERENCE CH_2M Hill

MDL/METHOD REQUIREMENTS ____

COMMENTS: ____

PROJECT: 13149-003 [redacted] 31

SAMPLING REQUEST FORM

SAMPLE ORDER AND LOCATION	STABILIZE	PREVIOUS VOLUME	40ML VIAL	40ML VIAL W/HCL	125ML AMBER W/TEFLON	500ML AMBER W/TEFLON	1L AMBER W/TEFLON	2L AMBER W/TEFLON	250ML PLASTIC	500ML PLASTIC	1L PLASTIC	250ML PLASTIC W/HNO3	500ML PLASTIC W/HNO3	1L PLASTIC W/HNO3	250ML PLASTIC W/H2SO4	500ML PLASTIC W/H2SO4	1L PLASTIC W/H2SO4	1500ML GLASS W/H2SO4	1L PLASTIC W/NAOH + ASCORBIC ACID	METHANE	FLOW	EH	APPEARANCE	TEMPERATURE	CONDUCTIVITY	PH	WATER LEVEL
1. MW6D	X			3				2					1	1					1				X	X	X	X	X
2. MW1S	X			3				2					1	1					1				X	X	X	X	X
3. MW1D	X			3				2					1	1					1				X	X	X	X	X
4. carbon filter infl				3				2					1	1					1				X	X	X	X	
5. carbon filter effl				3				2					1	1					1				X	X	X	X	
6. (MW4D) M-1				3				2					1	1					1				X	X	X	X	
7. (MW6S) M-2				3				2					1	1					1				X	X	X	X	
8. MW5S MS				3				2					1	1					1				X	X	X	X	
9. MW5S MSD				3				2					1	1					1				X	X	X	X	
(mw3) 10. FB-1				3				2					1	1					1								
(mw1) 11. FB-2				3				2					1	1					1								
12.																											
(1) LABORATORY	F			C				C					C	C					C				F	F	F	F	F

(1) LABORATORY CODES: A = ASPEN P = PACE E = ENSECO F = FIELD/BARR C = CH2M HILL B = BRAUN D = EDI

BARR CONTACT ______ SPLIT ______ SCHEDULED DATE April 6-10 COMPLETION DATE ______

SPECIAL INSTRUCTIONS CLP Procedures

PROJECT MGR. JSL/KAF SAMPLER ______ FORM COMPLETED BY: KAF DATE: 4-2-92

DISTRIBUTION: WHITE- PROJECT FILE: YELLOW- LAB COORDINATOR: PINK- PROJECT MANAGER

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: infleuent

Client WAKEGAN WCP RI/FS Project No. 13-49-003JSLB1

Location: ______ Date: 4/9/92 Sample Time: 1134

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N	—	1.	11.0	4500	6000	8.3	
Casing Dia: (in.)	—	2.					
Total Depth (ft.)	—	3.					
Static Depth (ft.)	—	4.					
Water Depth:	—	5.					
Well Vol. (gal.)	—	6.					
Purge Method:	—	7.					
Samp. Method:	—	Appearance:					
Start Time:	—	Odor:					
Stop Time:	—	Comments: 150 GAL IN TANK 2.2 PPM organic vapors in tank OVM "Inside of TANK"					
Duration: (min.)	—						
Rate, gpm:	—						
Volume Purged:	—						

Samplers: Others Present:

gen ___ VOC 3 COD ___ TOC ___ semi-volatile 2 f. metal 1 t. metal ___

nitro ___ cyanide 1 oil & grease ___ 200 ml filter ___ 500 ml filter ___

others ___

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: effleuent

Client WAKEGAN WCP RI/FS Project No. 17-49-003 JSL 311

Location: ______ Date: 4/9/92 Sample Time: 1155

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N		1. 1155	10	6000		8.2	
Casing Dia: (in.)		2.					
Total Depth (ft.)		3. 1240	9.0	6500	9000	8.2	
Static Depth (ft.)		4.					
Water Depth:		5.					
Well Vol. (gal.)		6.					
Purge Method:		7.					
Samp. Method:		Appearance: slight grey					
Start Time:		Odor: yes					
Stop Time:		Comments: 0.0 OVM Readings Clear, slight grey, Head space JAR					
Duration: (min.)							
Rate, gpm:							
Volume Purged:							

Samplers: Others Present:

gen ____ VOC 3 COD ____ TOC ____ semi-volatile 2 f. metal 1 t. metal ____

nitro ____ cyanide 1 ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MWGS-1

Client WCP RI/FS   Project No. 13-49-003JSK311

Location: ______   Date: 4/8/92   Sample Time: 1520

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N		1. 4.5	11.0	950		7.6	
Casing Dia: (in.)	2"	2. 6.0	11.0	800		7.5	
Total Depth (ft.)	17	3. 7.5	11.0	800		7.5	
Static Depth (ft.)	7.70	4. 9.0	11.0	800	1100	7.5	
Water Depth:	9.5	5.					
Well Vol. (gal.)	1.5	6.					
Purge Method:	cent	7.					
Samp. Method:	Bailer	Appearance:					
Start Time:	1504	Odor:					
Stop Time:	1509	Comments: M-2					
Duration: (min.)	5						
Rate, gpm:	2						
Volume Purged:	10						

Samplers: JEG KSJ   Others Present:

gen ____ VOC 6 ____ COD ____ TOC ____ semi-volatile 4 f. metal 2 t. metal ____

nitro ____ cyanide 2 ____ oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW6D-1

Client: WCP RI/FS. Project No. 13-49-0035401

Location: Date: 4/8/92 Sample Time: 1610

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N		1. 10.5	11.0	10,100		7.5	
Casing Dia: (in.)	2"	2. 14.0	11.0	10,100		7.5	
Total Depth (ft.)	29.5	3. 17.5	11.0	10,100	13,500	7.5	
Static Depth (ft.)	7.81	4.					
Water Depth:	21.5	5.					
Well Vol. (gal.)	3.5	6.					
Purge Method:	Cent	7.					
Samp. Method:	Bailer	Appearance: orange / milky					
Start Time:	1547	Odor: yes					
Stop Time:	1556	Comments:					
Duration: (min.)	9						
Rate, gpm:	2						
Volume Purged:	17.5						

Samplers: JEG KSJ Others Present:

gen ____ VOC 3 COD ____ TOC ____ semi-volatile 2 f. metal 1 t. metal ____

nitro ____ cyanide 1 oil & grease ____ 200 ml filter ____ 500 ml filter ____

others ____

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW15-1

Client WCP RI/FS

Project No. 13-49-003 JSL 311

Location:

Date: 4/9/92

Sample Time:

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @ 25	pH	Eh
Barr Lock: Y N		1. 6/GAL	11.0	1000		7.2	
Casing Dia: (in.)	2"	2. 8/GAL	11.0	900		7.2	
Total Depth (ft.)	20.0	3. 10/GAL	11.0	900		7.2	
Static Depth (ft.)	5.97	4. 12/GAL	11.0	900	1200	7.2	
Water Depth:	14	5.					
Well Vol. (gal.)	2	6.					
Purge Method:	Cent	7.					
Samp. Method:	Bailer	Appearance:					
Start Time:	0952	Odor:					
Stop Time:	1004	Comments: FB-2					
Duration: (min.)	12						
Rate, gpm:	1						
Volume Purged:	12 GAL						

Samplers: JEG KSJ Others Present:

gen ___ VOC 3 COD ___ TOC ___ semi-volatile 2 f. metal 1 t. metal ___

nitro ___ cyanide 1 oil & grease ___ 200 ml filter ___ 500 ml filter ___

others ___

Barr
Engineering Company

FIELD LOG DATA SHEET

Station: MW1P

Client: WCP RI/FS   Project No. 1 3 1 - 4 9 - 0 0 3 J S 6 3 1

Location: ______   Date: 4/9/92   Sample Time: 1035

General		Stabilization Test					
		TIME/ VOLUME	TEMP CENT.	COND. umhos	COND. @25	pH	Eh
Barr Lock Y N		1. 12/GAL	12.0	5000		8.6	
Casing Dia: (in.)	2"	2. 16/GAL	12.0	5000		8.6	
Total Depth (ft.)	30	3. 20/GAL	12.0	5000	6500	8.6	
Static Depth (ft.)	5.84	4.					
Water Depth:	24	5.					
Well Vol. (gal.)	4	6.					
Purge Method:	cent	7.					
Samp. Method:	Bailer	Appearance: Foamy					
Start Time:	1014	Odor: yes					
Stop Time:	1021	Comments:					
Duration: (min.)	7						
Rate, gpm:	3						
Volume Purged:	20						

Samplers: Others Present:

gen ___ VOC 3 COD ___ TOC ___ semi-volatile 2 f. metal 1 t. metal ___

nitro ___ cyanide 1 oil & grease ___ 200 ml filter ___ 500 ml filter ___

others ___

APPENDIX I

HYDROGEOLOGIC MODEL DEVELOPMENT

A preliminary simulation of groundwater flow in the vicinity of the site was performed using the Single Layer Analytic Element Model (SLAEM). SLAEM is described in the Revised Technical Memorandum, Proposed Modeling for RI/FS, Waukegan Manufactured Gas and Coke Plant (WCP) Site. The preliminary simulation was developed to provide an initial evaluation of steady-state groundwater flow patterns, to provide guidance in locating monitoring wells to be installed during the second phase of the investigation, to identify data gaps to be addressed during the second phase of the investigation, and to design the pumping test to be performed during Phase II.

The conceptual hydrogeologic model for the site consists of an unconfined homogeneous sand aquifer which overlies a relatively impermeable clay till. The aquifer is recharged by precipitation in areas not covered by buildings or impermeable materials, and groundwater may discharge to Lake Michigan, Waukegan Harbor, and the North Ditch north of OMC Plant No. 2. Given that the aquifer is essentially homogeneous and bounded on four sides by surface water bodies with similar water elevations, conceptual long-term groundwater flow patterns may be expected to consist of a groundwater divide (or mound) centered on the peninsula.

Several simplifying assumptions about the hydrogeologic conditions of the site were made during development of the model. The validity of these assumptions must be reevaluated with the additional hydrogeologic data that will be collected during the second phase of this investigation. First, it was assumed that the hydraulic conductivity of the sand unit is constant because the hydraulic conductivity estimates for the upper and basal portions of the sand aquifer are similar. Boring logs indicate that discontinuous layers of silty sand and silt with sand are present within the sand unit, but information on their extent and hydraulic properties is not available. However, the hydraulic conductivity estimates obtained during the first phase of the investigation are representative of both sands and silty sands (Fetter, 1988). Second, the aquifer base is assumed to be horizontal and not sloping. Third, the entire thickness of the aquifer is assumed to discharge to the North Ditch in areas north of OMC Plant No. 2. Finally, groundwater elevations measured on May 7, 1992 (the middle of a two-month period of water level measurements), are assumed to be representative of average steady-state flow patterns. Harbor levels remained essentially constant (580.5 ± 0.1) feet MSL) during the measurement period.

The Phase I modeling approach was to adjust infiltration until calibration was achieved, given: that predicted groundwater flow directions for the conceptual model would be essentially controlled by constant head boundaries and the proximity of those boundaries to areas receiving or not receiving infiltration; that the predicted groundwater elevations would be controlled by values of hydraulic conductivity and infiltration rate; and that both the constant head boundaries and hydraulic conductivity would remain constant in the model. If the infiltration rate necessary to achieve calibration was reasonable, it could also be concluded that the estimate of hydraulic conductivity used in the model was reasonable.

The configurations of hydrogeologic features included in the preliminary simulation of groundwater flow at the WCP site are discussed in the following paragraphs and illustrated on Figures I-1 through I-2. The data files for the model are attached.

The model addresses two-dimensional horizontal flow in the unconsolidated sand unit. The aquifer in the model has a hydraulic conductivity of 6 feet/day (2.1×10^{-3} cm/sec) beneath the site and in the vicinity of the OMC Plant No. 2 site (Figure I-1; JRB, 1981) and an assumed hydraulic conductivity of 20 feet/day everywhere else. Because the aquifer beneath the site and in the vicinity of OMC Plant No. 2 is bounded on all sides by a constant head boundary, as described below, the magnitude of the hydraulic conductivity outside these constant head boundaries (20 feet/day or 7.1×10^{-3} cm/sec) does not affect the solution for the aquifer beneath the site. The porosity of the unit was assumed to be 0.30 (Fetter, 1988). The impermeable lower boundary of the model is the till unit. The elevation of the base of the aquifer is 558 feet MSL, the average elevation at which the till unit was encountered in the soil borings.

The upper boundary of the aquifer is treated as an unconfined surface within the sand unit.

The presence of Lake Michigan/Waukegan Harbor on the east, south, and west sides of the site and the new boat slip are simulated using a series of head-specified linesinks. Based on the measurements of the water level in the harbor (Table 2.2-20), the elevation of the lake, harbor, and slip in the simulation was set at 580.5 feet MSL.

According to the 1981 JRB report for the OMC Plant No. 2 site, the ditch north of that site receives groundwater flow most of the year and has a water elevation that is an average of 0.5 feet higher than the lake (JRB, 1981). For this reason, the ditch is simulated as a head-specified linesink with an elevation of 581 feet MSL (Figure I-1).

The bentonite slurry wall on the east end of the new slip is simulated as a leaky wall with a thickness of 2 feet, an assumed porosity of 0.45, and an assumed hydraulic conductivity of 10^{-6} cm/sec.

The bluff to the west of the site represents the western boundary of the sand aquifer. The bluff could have been simulated by pinching the sand aquifer out using a series of thickness inhomogeneities or by placing a linesink with a specified head along the bluff. Because marshes exist at the base of the bluff northwest of the site, the bluff is represented by a linesink instead of inhomogeneities. The specified head of the linesink is 580 feet MSL, the approximate elevation of the groundwater in the marshes northwest of the site (Figure I-1).

Recharge to the aquifer is simulated as a large given-strength areal element centered on the peninsula (Figure I-2). Downward vertical hydraulic gradients in the sand aquifer indicate that the peninsula is a recharge area. The infiltration rate is set at 0.0013 feet/day, which is the equivalent of about 5.7 inches/year. This infiltration rate represents the infiltration rate that was necessary to achieve model calibration. It is considered a reasonable value for the hydrologic setting of the site because it falls within the range of infiltration rates (5.3 to 7.4 inches per year) published for surficial sand and gravel aquifers in northeast Illinois (Schicht et al., 1976).

Large areas of no infiltration, namely the OMC Plant No. 1 and Plant No. 2 and their adjacent parking lots, were simulated as areal elements having infiltration rates equal but opposite to the simulated recharge rate (Figure I-2).

The preliminary simulation was calibrated by fitting the simulated groundwater elevations at the shallow monitoring wells and piezometers to the actual field measurements made at these wells. The computed groundwater elevations were fitted to the groundwater elevation measurements made on May 7, 1992. In order to achieve model calibration, the infiltration rate was adjusted by trial and error until the differences between the observed and computed values at 90 percent of the observation points (8 of 9 observation points) were less than the total error associated with the observed groundwater elevations. A comparison between the observed and computed groundwater elevations is summarized in Table I-1. The total error associated with the observed groundwater elevations is presented in Table I-2. The largest source of error in the groundwater elevation measurements is due to the variation in groundwater elevations observed over the two-month monitoring period. Since the water level in the harbor remained essentially constant over this period, the calibration could not be more certain than the observed variation in groundwater levels.

The computed potentiometric surface for the preliminary simulation of current site conditions is shown on Figure I-3. The simulation shows that there is a potential for a groundwater mound on-site, centered on the peninsula. Predicted groundwater flow is towards the ditch and lake from the northern boundary of the site, toward the harbor and slip from most of the site, and toward the lake from the eastern fringe of the site. Groundwater from the southern portion of the site is predicted to be flowing to both the lake and harbor.

The groundwater flow patterns predicted by the preliminary model were compared to contour maps of measured groundwater elevations to assess the representativeness of the predicted flow-patterns and to help identity data gaps. Groundwater elevation contour maps prepared from measured data are shown on Figures 2.2-5 through 2.2-8. A second, more interpretive groundwater elevation contour map was prepared from the May 7, 1992 measured data to provide an alternative representation of flow patterns for comparison to the model results. This contour map is shown on Figure 2.2-9 and incorporates both the measured groundwater elevation data for May 7, 1992 and conceptual ideas of groundwater flow patterns (as derived from the preliminary model).

The general patterns of groundwater flow that were indicated by results of preliminary modeling indicate a potential for eastward flow from the eastern fringe of the site. This pattern of flow differs from that inferred from the water table elevation contour interpretations shown on Figures 2.2-5 through 2.2-8, which indicate flow toward the southeast from the northeast corner of the site. However, as shown on Figure 2.2-9, the actual water level data are not necessarily inconsistent with the concept of eastward flow from the eastern fringe of the site. In order to more fully assess the representativeness of the groundwater flow patterns predicted by the preliminary model, groundwater elevation measurements from the southern and northeastern portions of the site, as well as from areas north and east of the site, will be necessary. Section 3.3 describes the rationale for the locations of additional monitoring wells to be installed during the second phase of the investigation to provide data for such an assessment.

The preliminary groundwater flow modeling identified several data gaps to be addressed in the second phase of the investigation. These include the need for: water level measurements on the northeastern and southern portions of the site as well as north and east of the site to better define groundwater flow patterns, water level measurements in the North Ditch north of OMC Plant No. 2 to better understand the hydraulic connection between the North Ditch and the aquifer; more frequent water level measurements over a longer period of time to better understand the nature and magnitude of the variations in groundwater flow patterns and elevations over time; and geologic/hydrogeologic data to assess variable zones that may be present within the sand aquifer to determine their extent and hydraulic influence. Each of these data gaps is addressed in the work plan for the second phase of the investigation.

In addition to being used to assess groundwater flow patterns and identify data gaps, the preliminary model was used to design the pumping test to be conducted during the Phase II investigation. First, a general pumping well location was chosen based on the following factors: proximity to several possible monitoring points; location outside of source areas; and location near (but not adjacent to) surface water. For these reasons, it was decided to conduct pumping test scenarios in the vicinity of Monitoring Wells MW-1S and MW-1D and Piezometer P-104. The scenarios were conducted using the transient well feature in SLAEM and a specific storage of 0.01 feet^{-1}. Different pumping well locations (from 15 to 100 feet south and 0 to 120 feet east of Monitoring Wells MW-1S), pumping rates (10 to 25 gpm), and pumping test durations (one to two days) were simulated in an effort to optimize drawdown in the observation wells (MW-1S, MW-1D, P-104) and minimize the amount of water produced. The pumping well data file is attached. Two scenarios predicted observable drawdowns at Wells MW-1S and MW-1D and minimized water production. Each scenario had one pumping well that was pumping at a rate of 15 gpm. In one scenario, the pumping well was located 15 feet south of Well MW-1S. In the other scenario, the pumping well was located 25 feet south of Well MW-1S. The predicted drawdowns for these scenarios after one day of pumping are shown on Figures I-4 and I-5, respectively. None of the simulations predicted observable drawdown at Piezometer P-104.

TABLE I-1

GROUNDWATER FLOW MODEL CALIBRATION
OBSERVED AND CALCULATED GROUNDWATER ELEVATIONS

MONITORING WELL	OBSERVED ELEVATIONS (FT. MSL) 5/7/92	CALCULATED ELEVATIONS (FT. MSL)	DIFFERENCE (FT.)
MW-1S	581.63	581.49	-.14
MW-3S	582.27	582.22	-.05
MW-4S	582.15	582.39	.23
MW-5S	580.73	580.58	-.15
MW-6S	580.86	580.42	-0.44
P-101	581.80	581.61	-.19
P-102	582.36	582.15	-.21
P-103	581.81	582.36	.55
P-104	582.15	582.28	.13
		MEAN ABSOLUTE ERROR	.23

TABLE I-2

GROUNDWATER ELEVATION ERROR ANALYSIS

SOURCE OF ERROR	MAGNITUDE (FT.)
Well Survey Elevations	± 0.05
Water Level Measurements	± 0.02
Average Absolute Difference in Groundwater Elevation Measurements Over the Period of April 7 to May 7, 1992	± 0.40
Total Error	± 0.47

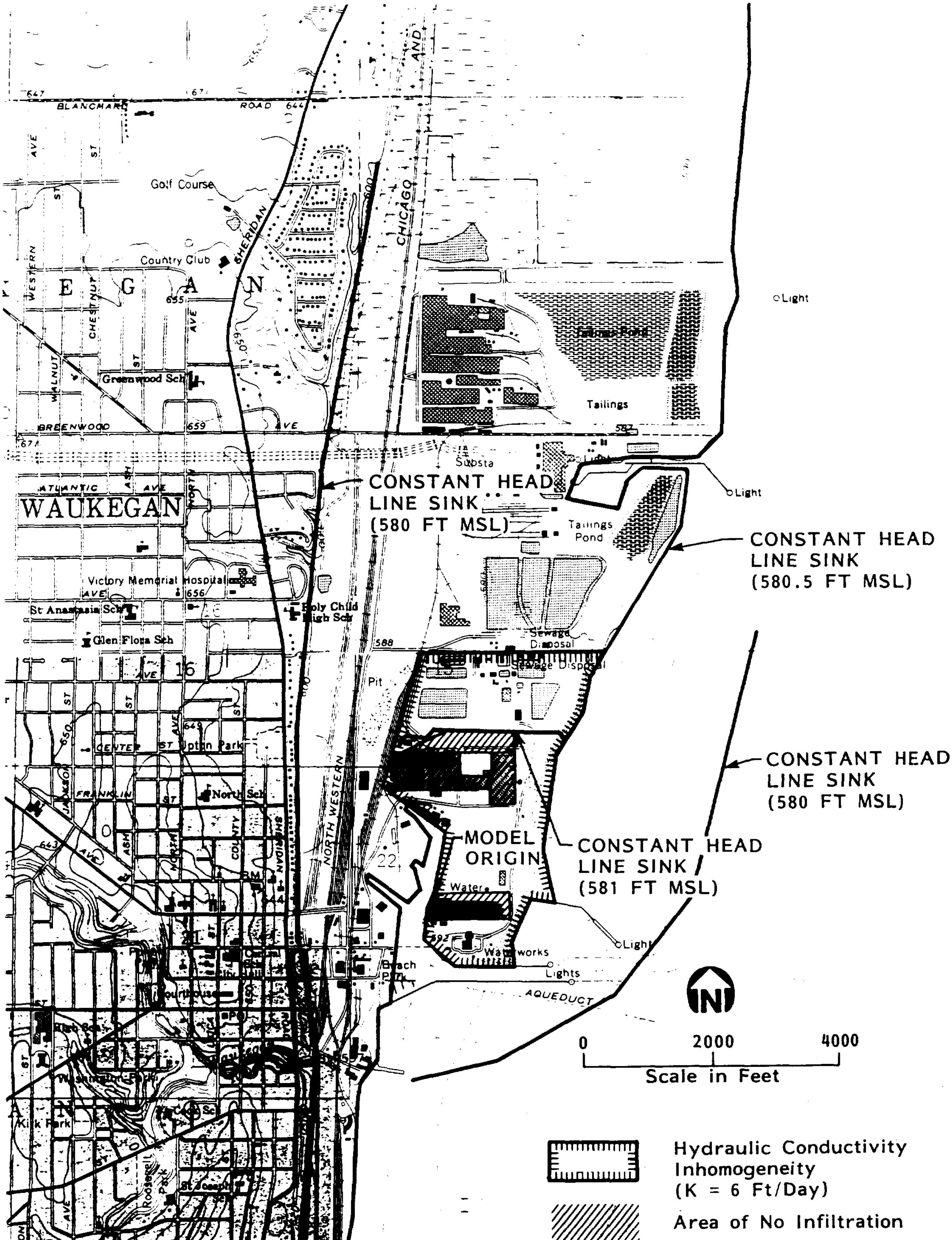


Figure I-1

GROUNDWATER FLOW SIMULATION ANALYTIC ELEMENTS

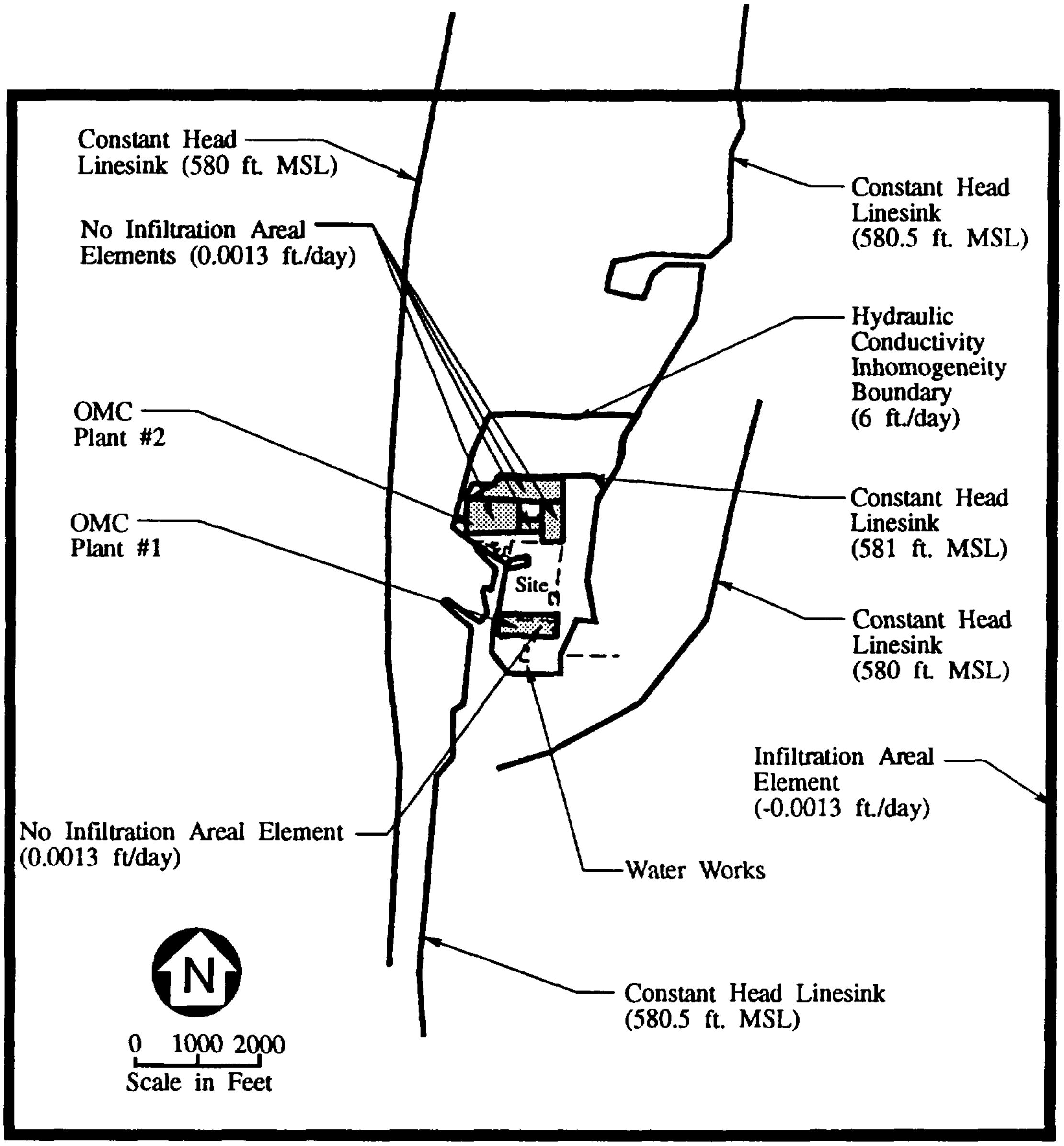


Figure I-2

GROUNDWATER FLOW SIMULATION
CURRENT SITE CONDITIONS
ANALYTIC ELEMENT LAYOUT

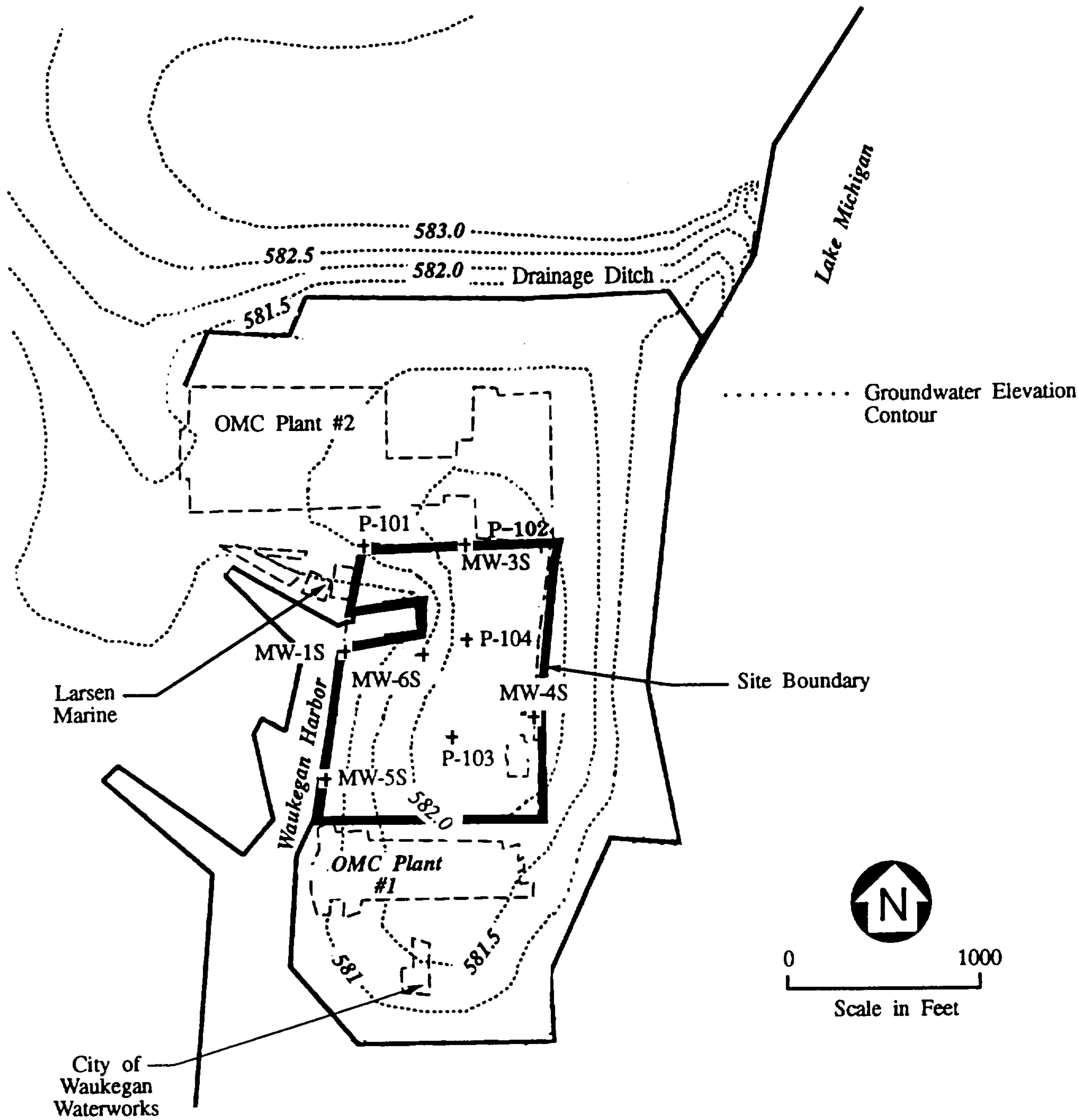


Figure I-3

PRELIMINARY GROUNDWATER FLOW SIMULATION
CURRENT SITE CONDITIONS

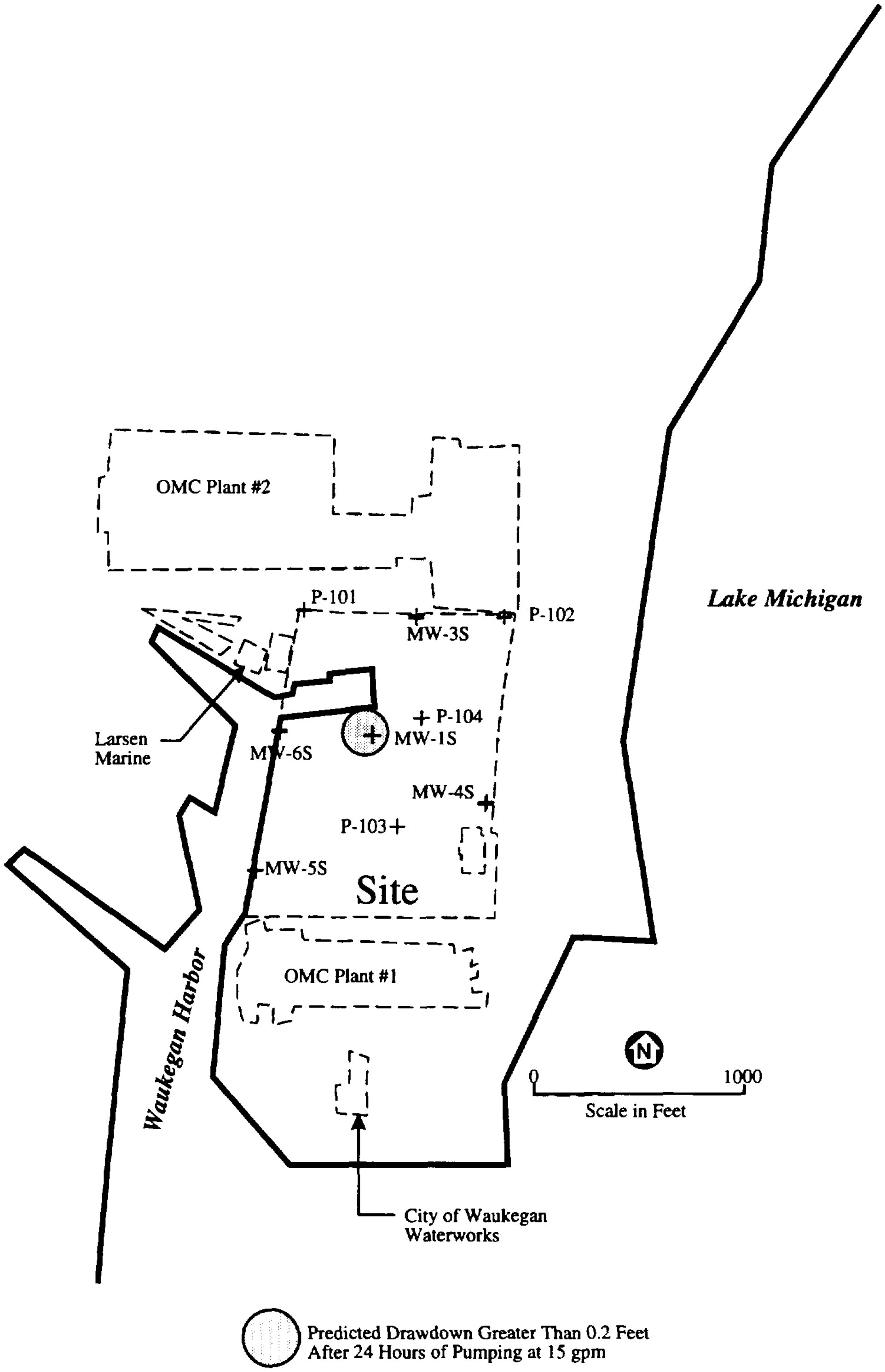


Figure I-4

PREDICTED DRAWDOWN
PUMPING WELL LOCATED 25 FEET
SOUTH OF MW-1S

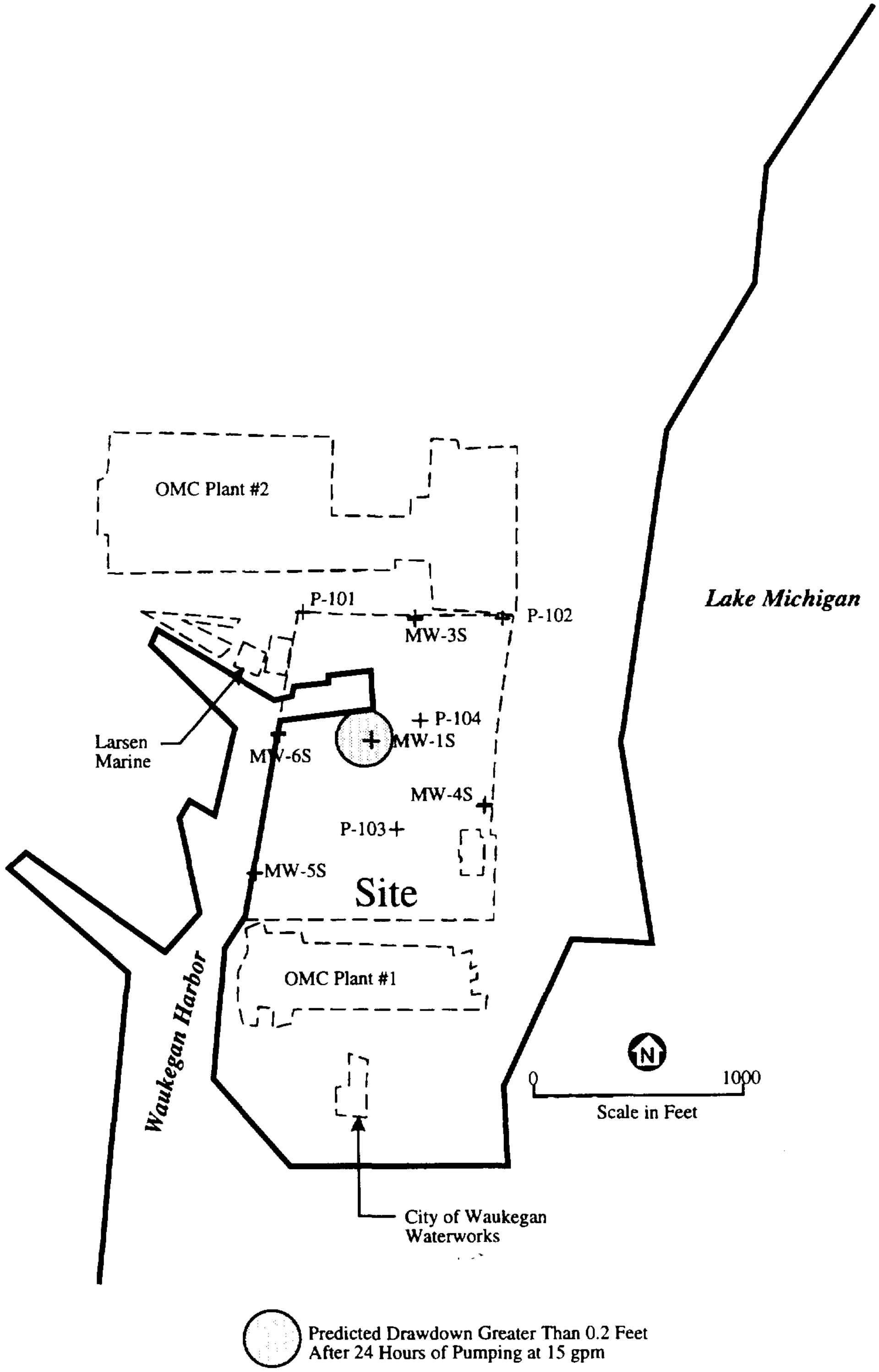


Figure I-5

PREDICTED DRAWDOWN
PUMPING WELL LOCATED 15 FEET
SOUTH OF MW-1S

```
************************************************************
*                 FILENAME: WCPCAL6                        *
* CALLFILE FOR SLAEM MODEL OF WAUKEGAN COKE PLANT SITE*
*                NEW SLIP AND DITCH ARE PRESENT            *
*         WCP RI/FS PHASE I 13/49-003JSL33                 *
*                    JULY 10, 1992                         *
************************************************************
CALL WCPAQU.DAT        * GLOBAL AQUIFER DATA FILE
CALL WCPINF2.DAT        * INFILTRATION AREAL ELEMENT MINUS BLDS AND PARKING LOTS
CALL LAKE.DAT          * LINE SINK IN LAKE MICHIGAN
CALL WCPMAP.DAT        * MAP FILE
CALL WCPLINE3.DAT       * LAKE MICHIGAN AND HARBOR LINE SINKS
CALL WCPDROOT.DAT      * SLURRY WALL OF SLIP
CALL WCPDOUB3.DAT       * HYDRAULIC CONDUCTIVITY INHOMOGENEITY OF SITE
CALL WCPDITCH.DAT      * DITCH NORTH OF SITE
END
```

```
RET
****************************************
*   FILENAME: WCPAQU.DAT               *
*   GLOBAL AQUIFER FILE                *
* WCP RI/FS PHASE I 13/49-003JSL33     *
*      JUNE 5, 1992                    *
****************************************
WINDOW -3000 -3000 6000 6000
REF
0 5000 580 *  ELEVATION OF LAKE MICHIGAN IN FEET MSL
RET
AQUI
 BASE 558
 PERM 20 * FEET/DAY
 THICK 100
 POR .3
 SS .001
RET
RET
SWI
BACK
```

```
RET
************************************
*   FILENAME: WCPINF2.DAT          *
*   INFILTRATION FILE              *
* NO INFILTRATION ON BLDS AND LOTS *
* WCP RI/FS PHASE I 13/49-003JSL33 *
*     JULY 10, 1992                *
************************************
RET
ARE
 GIVEN
* -9340 -9240 -9340 10760 10660 10760 10660 -9240 -.001  [INF] *INFILTRATION
-9400 -10000 -9400 10000 10600 10000 10600 -10000 -.0013  [INF] *INFILTRATION
-584.989 2212.13 -1.76896 2608.36 1218.70 2591.14 1218.70 2143.27 .0013
-652.793 2229.35 -666.301 1557.93 364.267 1592.36 364.267 2194.92 .0013
364.267 1833.38 364.267 1592.36 825.387 1592.36 811.879 1833.38   .0013
811.879 2160.48 811.879 1402.99 1218.70 1385.77 1218.70 2160.48   .0013
-29.0495 -9.24476 -69.5730 -422.425 1083.09 -456.857 1110.11 -26.4606 .0013
RET
RET
SWI
BACK
```

```
*****************************************
*     FILENAME: LAKE.DAT                *
*     LINE SINK IN LAKE MICHIGAN        *
*   WCP RI/FS PHASE I 13/49-003JSL33   *
*           JUNE 5, 1992                *
*****************************************
RET
LINE LINE
HEAD
 -0.382313E+02 -0.300000E+04 580
  0.974238E+03 -0.267817E+04 580
  0.274606E+04 -0.171414E+04 580
  0.401165E+04 -0.106949E+03 580
  0.451788E+04  0.214293E+04 580
  0.502411E+04  0.407146E+04 580
  RET
  RET
  SWI
  BACK
```

```
*****************************************************
*               FILENAME: WCPMAP.DAT                *
*    MAP FILE FOR THE WAUKEGAN COKE PLANT SITE      *
*        WCP RI/FS PHASE I 13/49-003JSL33           *
*                 JUNE 5, 1992                      *
*****************************************************
RET
RET
MAP
PLOT ON
CURVE * SITE BOUNDARY
-45.6872 -8.49399
1116.94 -18.2034
1126.22 370.631
1100.25 373.873
1131.99 877.556
1207.01 1381.08
397.047 1392.66
212.914 1411.43
-45.6872 -8.49399
CURVE * OMC OFFICE
1016.46 57.7289
1016.23 -6.03198
1059.52 -5.40117
1059.76 59.9341
1016.46 57.7289
CURVE * OMC OFFICE (LARGE)
962.582 396.412
963.110 324.776
952.087 324.029
954.261 272.067
963.709 272.820
964.184 186.228
1068.88 186.637
1070.25 348.792
1064.74 349.599
1064.78 361.407
1052.2 363.026
1052.32 397.662
962.582 396.412
CURVE * CANONIE TRAILER
878.272 591.938
878.843 532.110
901.671 532.027
904.234 587.908
```

878.272 591.938
CURVE * SOIL STOCKPILE
261.936 817.724
267.531 623.269
461.173 621.783
461.094 817.792
261.936 817.724
CURVE * LARSEN GATE
673.316 1383.79
672.645 1198.02
685.231 1195.61
685.035 923.252
380.296 896.014
382.581 874.752
119.580 852.087
CURVE * OMC PLANT 1
-30.9679 -47.4554
47.3005 -15.2524
63.5569 -70.1022
228.570 -68.4812
236.891 -115.551
928.685 -140.189
929.071 -179.478
1015.27 -155.056
1008.26 -241.569
1039.54 -225.544
1040.16 -288.407
1008.80 -296.573
1017.28 -359.358
1087.92 -350.806
1080.83 -429.461
192.754 -422.467
177.656 -485.484
91.4525 -509.907
98.3842 -415.536
27.5868 -408.373
20.5779 -494.886
-42.3614 -487.646
-58.7722 -417.080
-66.9380 -385.726
-68.2502 -252.144
-22.1074 -149.529
-30.9679 -47.4554
CURVE * OMC PLANT 2
-660.008 1588.80

```
660.177 1593.91
659.714 1641.05
816.947 1634.74
834.824 1414.88
1220.16 1387.23
1220.45 2157.37
953.369 2146.89
945.126 2186.10
827.182 2192.80
814.091 1925.48
735.513 1924.71
728.504 1838.19
366.969 1842.50
371.276 2204.04
-650.621 2233.29
-664.330 2028.83
-703.465 2012.73
-708.852 1761.21
-661.706 1761.67
-660.008 1588.80
CURVE * LARSEN MARINE
-41.1988 1269.64
-87.0026 1158.56
24.0836 1112.75
62.1084 1215.84
-41.1988 1269.64
CURVE * LARSEN MARINE
-508.662 1413.09
-150.650 1197.13
-88.3094 1253.21
-318.695 1368.38
-81.5096 1332.20
-58.3904 1371.97
-508.662 1413.09
CURVE * WATERWORKS BUILDING
389.516 -783.577
391.259 -909.785
533.461 -923.601
531.501 -781.616
537.646 -655.299
450.443 -624.944
452.512 -774.817
389.516 -783.577
POINT
235.660 1403.45 * P-101
```

```
1157.41 1367.96 * P-102
668.253 403.398 * P-103
774.191 902.794 * P-104
753.488 1378.38 * MW-3S
753.432 1365.80 * MW-3D
1070.31 504.591 * MW-4S
1075.85 513.998 * MW-4D
10.3217 202.728 * MW-5S
11.9143 207.437 * MW-5D
121.572 838.07 * MW-6S
121.621 849.072 * MW-6D
530.194 822.128 * MW-1S
527.026 816.640 * MW-1D
CURVE * LARSEN MARINE
53.9722 1131.73
83.9402 1297.45
181.321 1278.85
153.724 1115.48
53.9722 1131.73
CURVE * SCALE BAR 1000 FEET LONG
1300 -833
2300 -833
RET
RET
SWI
BACK
CURVE * 581 WATER TABLE ELEVATION
169.354 1159.31
347.047 1175.03
478.225 1157.95
565.276 1115.13
604.972 1026.93
592.824 945.246
507.723 895.319
388.175 876.196
243.440 848.537
178.817 808.738
141.471 716.161
133.046 587.303
157.357 396.211
201.513 249.831
300.122 154.299
411.524 108.224
537.952 83.3053
714.852 97.4613
```

```
844.752 147.191
939.312 203.364
1043.44 292.504
1140.59 399.752
1201.95 591.253
1223.91 760.921
1245.89 932.946
1259.87 1075.14
1275.36 1200.82
1299.71 1375.98
CURVE * 582 WATER TABLE ELEVATION
458.788 1385.17
538.490 1279.51
596.269 1192.80
647.616 1073.11
688.046 973.122
714.147 831.537
735.497 682.114
811.959 554.455
926.314 465.141
1030.02 457.612
1087.64 512.375
1103.79 612.119
1120.91 751.156
1147.71 949.097
1178.68 1200.46
1203.76 1362.25
1222.39 1488.71
RET
RET
SWI
BACK
```

```
*******************************************************************
*                    FILENAME: WCPLINE3.DAT                       *
* LINESINKS REPRESENTING LAKE MICHIGAN, THE HARBOR, AND THE BLUFF *
*               THE NEW SLIP AND DITCH ARE PRESENT                *
*                WCP RI/FS PHASE I 13/49-003JSL33                 *
*                         JUNE 12, 1992                           *
*******************************************************************
RET
RET
LINE * LAKE MICHIGAN
HEAD
4816.24 13916.7 4870.43 12810.8 580
4870.43 12810.8 4565.89 10064.6 580
4565.89 10064.6 4675.58 9313.23 580
4675.58 9313.23 4457.39 8853.39 580
4457.39 8853.39 4428.73 7196.27 580
4428.73 7196.27 4035.46 6850.58 580
4035.46 6850.58 2927.35 6906.25 580
2927.35 6906.25 2184.42 6765.33 580
2184.42 6765.33 2038.79 6212.77 580
2038.79 6212.77 2756.63 6046.99 580
2756.63 6046.99 2943.44 6506.19 580
2943.44 6506.19 3182.83 6699.54 580
3182.83 6699.54 3920.82 6699.05 580
3920.82 6699.05 3769.20 5675.32 580
3769.20 5675.32 2372.00 3377.63 580
2372.00 3377.63 2266.09 2802.34 580
2266.09 2802.34 2076.21 2492.245 580
2076.21 2492.245 2001.54 2405.52 580
2001.54 2405.52 1886.33 2182.15 580
1886.33 2182.15 1788.31 1414.6745 580
1788.31 1414.6745 1690.29 647.199 580
1690.29 647.199 1765.405 240.504 580
1765.405 240.504 1840.52 -166.191 580
1840.52 -166.191 1663.545 -150.211 580.5
1663.545 -150.211 1486.57 -134.231 580.5
1486.57 -134.231 1324.885 -479.0745 580.5
1324.885 -479.0745 1163.20 -823.918 580.5
1163.20 -823.918 1170.76 -1000.404 580.5
1170.76 -1000.404 1178.32 -1176.89 580.5
1178.32 -1176.89 923.11625 -1174.2975 580.5
923.11625 -1174.2975 667.9125 -1171.705 580.5
667.9125 -1171.705 412.70875 -1169.1125 580.5
412.70875 -1169.1125 157.505 -1166.52 580.5
157.505 -1166.52  72.9635 -1064.2408 580.5
```

```
72.9635 -1064.2408 -11.578 -961.9615 580.5
-11.578 -961.9615 -96.1195 -859.68225 580.5
-96.1195 -859.68225 -180.661 -757.403 580.5
-180.661 -757.403 -159.0975 -470.40303 580.5
-159.0975 -470.40303 -137.534 -183.403 580.5
-137.534 -183.403 -92.30935 -92.186671 580.5
-92.30935 -92.186671 -47.0847 -.970341 580.5
*-47.0847 -.970341 91.3485 985.828    580.5 * TURN OFF WHEN SLIP IS ON
-47.0847 -.970341 105.520 883.356 580.5 * SLIP
105.520 883.356 342.178 905.628 580.5   * SLIP
342.178 905.628 342.215 924.548 580.5   * SLIP
342.215 924.548 515.000 941.173 580.5   * SLIP
RET                                   * SLIP
RET                                   * SLIP
LINE                                  * SLIP
HEAD                                  * SLIP
504.000 1109.52 339.405 1092.77 580.5   * SLIP
339.405 1092.77 342.507 1071.54 580.5   * SLIP
342.507 1071.54 182.897 1054.57 580.5   * SLIP
182.897 1054.57 171.001 1001.92 580.5   * SLIP
171.001 1001.92 127.760 998.867 580.5   * SLIP
127.760 998.867 91.3485 985.828 580.5   * SLIP
91.3485 985.828 -458.782 1309.48    580.5
-458.782 1309.48 -481.192 1254.06    580.5
-481.192 1254.06 -88.2545 853.922    580.5
-88.2545 853.922 -182.025 451.596    580.5
-182.025 451.596 -301.192 519.798    580.5
-301.192 519.798 -346.660 440.353    580.5
-346.660 440.353 -251.281 2.67227    580.5
-251.281 2.67227 -412.521 -173.368  580.5
-412.521 -173.368 -1050.18 292.390  580.5
-1050.18 292.390 -1127.20 220.146    580.5
-1127.20 220.146 -575.377 -270.935  580.5
-575.377 -270.935 -709.932 -1741.81 580.5
-709.932 -1741.81 -927.237 -1864.05 580.5
-927.237 -1864.05 -908.638 -2766.51 580.5
-908.638 -2766.51 -1230.47 -3149.99 580.5
-1230.47 -3149.99 -1561.39 -6901.65 580
-1561.39 -6901.65 -1465.38 -8132.26 580
RET
RET
LINE * BLUFF 600 FT MSL
HEAD
-952.018 11528.9 -1814.39 7279.58 580
-1814.39 7279.58 -2191.77 1972.49 580
```

```
-2191.77 1972.49 -2196.82 -830.356 580
-2196.82 -830.356 -1940.62 -2976.20 580
-1940.62 -2976.20 -2145.18 -6764.52 580
RET
RET
SWI
BACK
```

```
*****************************************************************
*                   FILENAME: WCPDROOT.DAT                      *
* DROOT ELEMENT REPRESENTING THE SLURRY WALL OF THE NEW SLIP *
*            WCP RI/FS PHASE I 13/49-003JSL33                   *
*                      JUNE 5, 1992                             *
*****************************************************************
RET
DROOT * SLURRY WALL OF NEW SLIP
  LEAK
  505.944 1109.52 536.623 1109.49 710 2 .45
  539.770 1110.28 548.286 945.080 710 2 .45
  543.565 944.297 516.817 941.173 710 2 .45
  RET
  RET
  SWI
  BACK
```

```
****************************************************************
*                FILENAME: WCPDOUB3.DAT                        *
* DOUBLET ELEMENT REPRESENTING HYDRAULIC CONDUCTIVITY OF THE *
*               WAUKEGAN COKE PLANT SITE                       *
*               THE NEW SLIP IS PRESENT                        *
*           WCP RI/FS PHASE I 13/49-003JSL33                   *
*                   JUNE 12, 1992                              *
****************************************************************
RET
RET
doub
inhom 6 100 558 .3
1788.31 1414.6745
1690.29 647.199
1765.405 240.504
1840.52 -166.191
1663.545 -150.211
1486.57 -134.231
1324.885 -479.0745
1163.20 -823.918
1170.76 -1000.404
1178.32 -1176.89
923.11625 -1174.2975
667.9125 -1171.705
412.70875 -1169.1125
157.505 -1166.52
72.9635 -1064.2408
-11.578 -961.9615
-96.1195 -859.68225
-180.661 -757.403
-159.0975 -470.40303
-137.534 -183.403
-92.30935 -92.186671
*-47.0847 -.970341 * TURN OFF WHEN SLIP IS ON
-47.0847 -.970341 * SLIP
105.520 883.356  * SLIP
342.178 905.628  * SLIP
342.215 924.548  * SLIP
515.000 941.173  * SLIP
504.000 1109.52  * SLIP
339.405 1092.77  * SLIP
342.507 1071.54  * SLIP
182.897 1054.57  * SLIP
171.001 1001.92  * SLIP
127.760 998.867  * SLIP
```

```
91.3485 985.828
-458.782 1309.48
-927.451 1690.90
-805.707 2156.09
-691.411 2574.01
-554.215 3070.80
-353.605 3513.09
-222.535 3813.17
272.793 3841.15
784.269 3822.08
1288.15 3771.47
1775.55 3807.25
2137.30 3818.32
2664.51 3799.39
2400.69 3388.01
2379.67 3096.77
2266.09 2802.34
2076.21 2492.245
1886.33 2182.15
RET
RET
SWI
BACK
```

```
****************************************************
*           FILENAME: WCPDITCH.DAT                 *
* LINE SINK REPRESENTING LINE SINK NORTH OF SITE *
*       WCP RI/FS PHASE I 13/49-003JSL33           *
*               JUNE 12, 1992                      *
****************************************************
RET
RET
LINE
HEAD
-674.645 2240.11 -550.247 2508.56 581
-550.247 2508.56 -124.879 2479.57 581
-124.879 2479.57 -39.4300 2676.93 581
-39.4300 2676.93 480.376 2656.38  581
480.376 2656.38 1086.79 2636.33   581
1086.79 2636.33 1834.70 2656.50   581
1834.70 2656.50 2001.54 2405.52   581
RET
RET
SWI
BACK
```

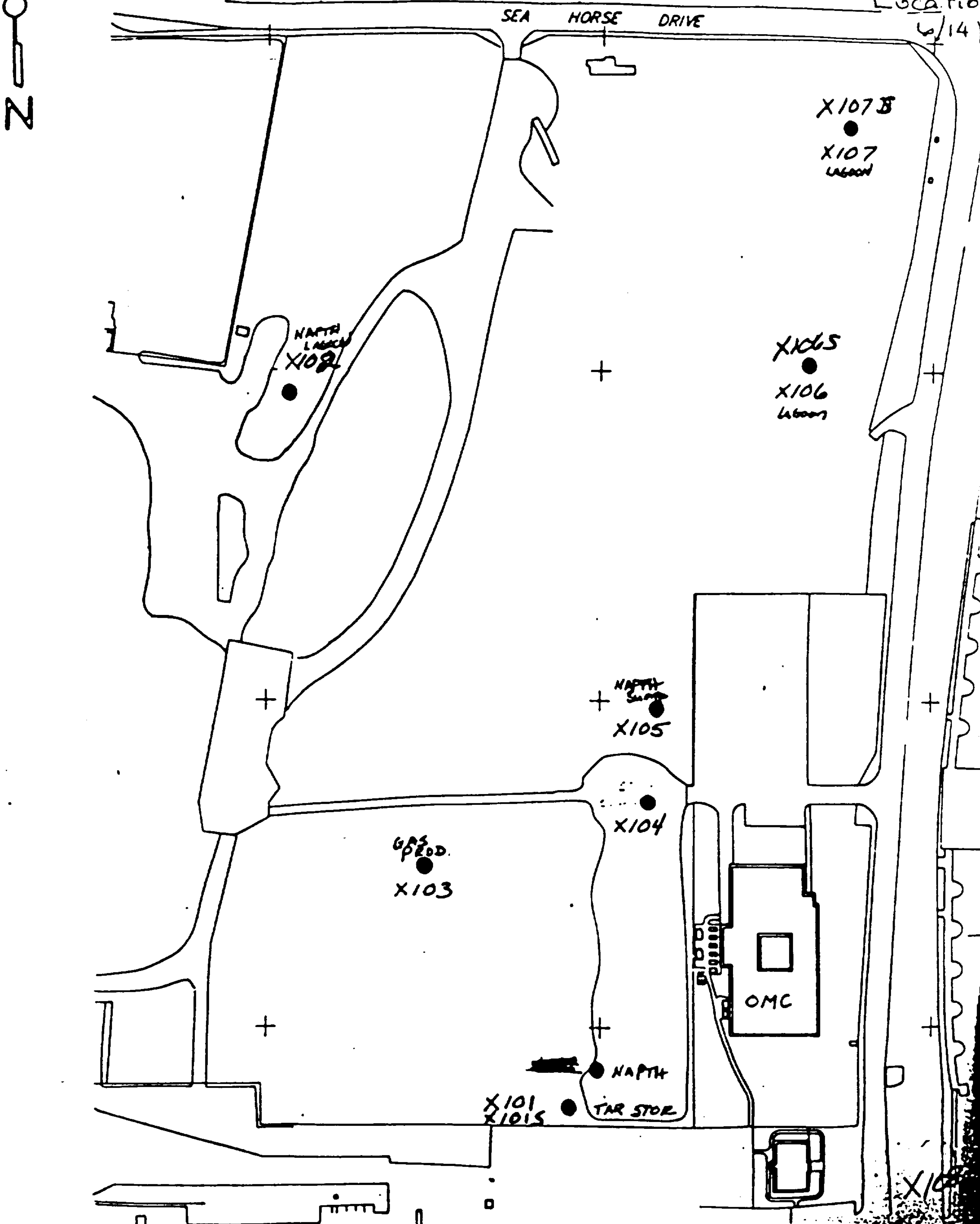
```
*********************************************
*          FILENAME: WCPPWELL.DAT           *
*           PUMPING TEST DESIGN             *
*     WCP RI/FS PHASE I 13/49-003JSL33      *
*               JUNE 5, 1992                *
*********************************************
RET
WELL
TWELL
530.194 807.128 2888 0 * PUMPING WELL 15 FEET SOUTH OF MW-1S, 15 GPM
530.194 807.128 -2888 1 * SHUT OFF PUMPING WELL AFTER ONE DAY
*530.194 797.128 2888 0 * PUMPING WELL 25 FEET SOUTH OF MW-1S, 15 GPM
*530.194 797.128 -2888 1 * SHUT OFF PUMPING WELL AFTER ONE DAY
*530.194 797.128 4813 0 * PUMPING WELL 25 FEET SOUTH OF MW-1S, 25 GPM
*530.194 797.128 -4813 1 * SHUT OFF PUMPING WELL AFTER ONE DAY
*530.194 772.128 1925 0 * PUMPING WELL 50 FEET SOUTH OF MW-1S, 10 GPM
*530.194 772.128 -1925 2 * SHUT OFF PUMPING WELL AFTER TWO DAYS
*530.194 722.128 2888 0 * PUMPING WELL 100 FEET SOUTH OF MW-1S, 15 GPM
*530.194 722.128 -2888 1 * SHUT OFF PUMPING WELL AFTER ONE DAY
*580.194 747.128 2888 0 * PUMPING WELL 75 FT SOUTH AND 50 FT E OF MW-1S, 15 GPM
*580.194 747.128 -2888 2 * SHUT OFF PUMPING WELL AFTER TWO DAYS
*650.194 822.128 2888 0 * PUMPING WELL 120 FEET EAST OF MW-1S, 15 GPM
*650.194 822.128 -2888 2 * SHUT OFF PUMPING WELL AFTER TWO DAYS
RET
RET
SWI
BACK
```

Appendix J

IEPA Investigation Soil Quality Data

GM Coke Plant SuperFund/HES Sample Location

6/14



PROPOSED SOIL SAMPLE LOCATIONS

PUT SITE NAME HERE G-M Coke Plant
PUT USEPA NUMBER HERE ALD 980993570

TABLE 4-1
SUMMARY

SAMPLING POINT	X101 4'-5'	X101.5 0'-1'	X102 4'-5'	X103 5'-6'	X104 1.5'-2.5'	X105 3.5'-4.5'	X106 4'-4.5'	X106.5 0'-1'	X107 5'-1' ?
VOLATILES (ppb)	6-14-89	6-14-89	6-14-89	6-14-89	6-14-89	6-14-89	6-14-89	6-14-89	6-14-89
Chloromethane	—	—	—	—	—	—	—	—	—
Bromomethane	—	—	—	—	—	—	—	—	—
Vinyl Chloride	—	—	—	—	—	—	—	—	—
Chloroethane	—	—	—	—	—	—	—	—	—
Methylene Chloride	2.0 BJ	26.0 B	2.0 B	33.0 B	330 BJ	100 BJ	210 B	510 B	340 B
Acetone	—	41.0	190	170	[illegible]	—	160	11.0 J	20.0
Carbon Bisulfide	—	—	—	—	—	—	1.0 BJ	—	—
1,1-Dichloroethene	—	—	—	—	—	—	—	—	—
1,1-Dichloroethane	—	—	—	—	—	—	—	—	—
1,2-Dichloroethene(total)	—	—	—	—	—	—	—	—	—
Chloroform	—	—	—	—	—	—	—	—	—
1,2-Dichloroethane	—	—	—	—	—	—	—	—	—
2-Butanone (MEK)	—	—	—	—	—	—	12.0 J	—	—
1,1,1-Trichloroethane	—	—	—	—	—	—	—	—	—
Carbon Tetrachloride	—	—	—	—	—	—	—	—	—
Vinyl Acetate	—	—	—	—	—	—	—	—	—
Bromodichloromethane	—	—	—	—	—	—	—	—	—
1,2-Dichloropropane	—	—	—	—	—	—	—	—	—
cis-1,3-Dichloropropene	—	—	—	—	—	—	—	—	—
Trichloroethene	—	—	—	—	—	—	—	—	—
Dibromochloromethane	—	—	—	—	—	—	—	—	—
1,1,2-Trichloroethane	—	—	—	—	—	—	—	—	—
Benzene	—	2.0 J	—	0.8 J	1800	—	6.0 J	3.0 J	2.0 J
Trans-1,3-Dichloropropene	—	—	—	—	—	—	—	—	—
Bromoform	—	—	—	—	—	—	—	—	—
4-Methyl-2-Pentanone	—	—	—	—	—	—	—	—	—
2-Hexanone	—	—	—	—	—	—	—	—	—
Tetrachloroethene	—	—	—	—	—	—	—	—	—
Toluene	—	2.0 J	—	—	1900	230 J	1.0 J	1.0 J	2.0 J
1,1,2,2-Tetrachloroethane	—	—	—	—	—	—	—	—	—
Chlorobenzene	—	—	—	—	—	—	—	—	—
Ethylbenzene	—	—	—	—	610	—	0.8 J	—	3.0 J
Styrene	—	—	—	—	410 J	—	—	—	—
Xylene(total)	—	—	—	—	2500	1800	11.0	0.6 J	—
SEMIVOLATILES (ppb)									
Phenol	—	—	—	—	[illegible]	—	210 J	—	—
bis(2-Chloroethyl) ether	—	—	—	—	—	—	—	—	—

PUT SITE NAME HERE
PUT USEPA NUMBER HERE

TABLE 4-1

PUT SITE NAME HERE
PUT USEPA NUMBER HERE

TABLE 4-1
SUMMARY

SAMPLING POINT	X107S 6-14-89 0'-.5'	X108 6-14-89 3'-4.5'	BLANK 6-14-89						
VOLATILES									
Chloromethane	--	--	--	--	--	--	--	--	--
Bromomethane	--	--	--	--	--	--	--	--	--
Vinyl Chloride	--	--	--	--	--	--	--	--	--
Chloroethane	--	--	--	--	--	--	--	--	--
Methylene Chloride	-- 68.0 B	-- 17.0 B	-- 0.3 J	--	--	--	--	--	--
Acetone	-- 16 B	-- 210	--	--	--	--	--	--	--
Carbon Disulfide	--	--	-- 0.1 J	--	--	--	--	--	--
1,1-Dichloroethene	--	--	--	--	--	--	--	--	--
1,1-Dichloroethane	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene(total)	--	--	--	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--	--	--	--
2-Butanone (MEK)	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--	--
Carbon Tetrachloride	--	--	--	--	--	--	--	--	--
Vinyl Acetate	--	--	--	--	--	--	--	--	--
Bromodichloromethane	--	--	--	--	--	--	--	--	--
1,2-Dichloropropane	--	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--
Trichloroethene	--	--	--	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--	--	--	--
Benzene	-- 4.0 J	-- 0.9 J	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--	--	--	--
4-Methyl-2-Pentanone	--	--	--	--	--	--	--	--	--
2-Hexanone	--	--	--	--	--	--	--	--	--
Tetrachloroethene	--	--	--	--	--	--	--	--	--
Toluene	-- 2.0 J	--	--	--	--	--	--	--	--
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--
Chlorobenzene	--	--	--	--	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--	--
Styrene	--	--	--	--	--	--	--	--	--
Xylene(total)	-- 1.0 J	--	--	--	--	--	--	--	--
SEMIVOLATILES									
Phenol	--	--	--	--	--	--	--	--	--
bis(2-Chloroethyl) ether	--	--	--	--	--	--	--	--	--

PUT SITE NAME HERE
PUT USEPA NUMBER HERE

TABLE 4-1
SUMMARY

SAMPLING POINT	X101 6-14-89	X101S 6-14-89	X102 6-14-89	X103 6-14-89	X104 6-14-89	X105 6-14-89	X106 6-14-89	X106S 6-14-89	X107 6-14-89
2-Chlorophenol	--	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	--	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	--	--	--	--	--	--	--	--	--
Benzyl Alcohol	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	--	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--
bis(2-Chloroisopropyl)ether	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	--	--	--
N-Nitroso-di-n-Dipropylamine	--	--	--	--	-- 2700	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--
Isopherone	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--
Benzoic acid	--	--	--	--	--	--	--	--	--
bis(2OChloroethoxy) Methane	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	--	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--	--	--
Naphthalene	-- 7100 J	-- 32,000	-- 220 J	-- 1100	-- 190,000 D	-- 170,000	-- 14,000	-- 16,000	-- 9200
4-Chloroaniline	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	--	--	--	--	--	--	--	--	--
2-Methylnaphthalene	-- 6300	-- 21,000	-- 66 J	-- 280 J	-- 110,000 D	-- 97,000	-- 480 J	-- 2300 J	-- 5300 J
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--
2-Nitroaniline	--	--	--	--	--	--	--	--	--
Dimethylphthalate	--	--	--	--	--	--	--	--	--
Acenaphthylene	-- 5700 J	-- 15,000	-- 200 J	--	-- 45,000 D	-- 2700 J	--	-- 1900 J	-- 1600 J
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--
Acenaphthene	-- 2100 J	-- 6300 J	-- 110 J	--	-- 7000	-- 2400 J	-- 64 J	--	--
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--
4-Nitrophenol	--	--	--	--	--	--	--	--	--
Dibenzofuran	-- 21,000	-- 64,000	-- 230 J	-- 150 J	-- 38,000 D	-- 14,000 J	-- 230 J	-- 1400 J	-- 1900 J
2,4-Dinitrotoluene	--	--	--	--	--	--	--	--	--
Diethylphthalate	--	--	--	--	--	--	--	--	--
4-Chlorophenyl-phenyl ether	--	--	--	--	--	--	--	--	--
Fluorene	-- 24,000	-- 92,000	-- 380 J	-- 240 J	-- 49,000 D	-- 16,000	-- 320 J	-- 1300 J	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-Methylphenol	--	--	--	--	--	--	--	--	--

PUT SITE NAME HERE
TABLE 4-1

PUT SITE NAME HERE
PUT USEPA NUMBER HERE

TABLE 4-1
SUMMARY

SAMPLING POINT	X1075 6-14-89	X108 6-14-89	BLANK 6-14-89						
2-Chlorophenol	--	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	--	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	--	--	--	--	--	--	--	--	--
Benzyl Alcohol	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	--	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--
bis(2-Chloroisopropyl)ether	--	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	--	--	--
N-Nitroso-di-n-Dipropylamine	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--
Isophorone	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--
Benzoic acid	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy) Methane	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	--	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--	--	--
Naphthalene	-- 2000	--	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	--	--	--	--	--	--	--	--	--
2-Methylnaphthalene	-- 1200 J	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--
2-Nitroaniline	--	--	--	--	--	--	--	--	--
Dimethylphthalate	--	--	--	--	--	--	--	--	--
Acenaphthylene	-- 1100 J	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--
Acenaphthene	-- 130 J	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--
4-Nitrophenol	--	--	--	--	--	--	--	--	--
Dibenzofuran	-- 1600	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene									
Diethylphthalate	--	--	--	--	--	--	--	--	--
4-Chlorophenyl-phenyl ether	--	--	--	--	--	--	--	--	--
Fluorene	-- 3000	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-Methylphenol	--	--	--	--	--	--	--	--	--

PUT SITE NAME HERE
PUT USEPA NUMBER HERE

TABLE 4-1
SUMMARY

SAMPLING POINT	X101 6-14-89	X101S 6-14-89	X102 6-14-89	X103 6-14-89	X104 6-14-89	X105 6-14-89	X106 6-14-89	X106S 6-14-89	X107 6-14-89
N-Nitrosodiphenylamine	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--
Phenanthrene	--210,000 D	--370,000 D	--1900	--800	--59,000 D	--21,000	--400 J	--2800	--42,000
Anthracene	--27,000	--76,000	--370 J	--160 J	--19,000	--2200 J	--190 J	--2900 J	--1100 J
Di-n-Butylphthalate	--	--	--	--	--	--	--90 J	--	--
Fluoranthene	--310,000 D	--320,000 D	--6300	--1400	--43,000	--9800 J	--470 J	--15,000	--14,000
Pyrene	--170,000 D	--340,000 D	--4900	--300 J	--9700	--6300 J	--420 J	--11,000	--7500
Butylbenzylphthalate	--	--	--	--	--	--	--350 J	--	--
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--1100 J	--	--
Benzo(a)anthracene	--180,000	--150,000 D	--4000	--960	--8500	--5500 J	--510 J	--8600	--9100
Chrysene	--110,000	--160,000 D	--5200 ?	--710 J	--6600	--3400 J	--630 J	--7900	--6900 J
bis(2-Ethylhexyl)phthalate	--	--	-- .3520	--70 BJ	--	--	--1100 BJ	--	--
Di-n-Octylphthalate	--	--	--	--	--	--	--170 J	--	--
Benzo(b)fluoranthene	--100,000	--97,000 D	--6000	--800 J	--7700	--	--590 J	--14,000	--
Benzo(k)fluoranthene	--91,000	--140,000	--9900	--590 J	--6700	--	--600 J	--9700	--
Benzo(a)pyrene	--94,000	--120,000	--3000	--600 J	--6000	--	--670 J	--6300 J	--
Indeno(1,2,3-cd)pyrene	--47,000	--60,000	--	--	--4800	--	--370 J	--	--
Dibenz(a,h)anthracene	--	--6300 J	--	--	--1400 J	--	--380 J	--	--
Benzo(g,h,i)perylene	--	--47,000	--	--	--3300	--	--	--	--
CPAHs (ppm)	564	700	51	5	39	7	4	43	15
+PAHs (ppm)	1299	1961	65	11	1753	290	21	97	63
PESTICIDES (ppb)									
alpha-BHC	--	--	--	--	--	--	--	--	--
beta-BHC	--	--	--	--	--	--	--	--	--
delta-BHC	--	--	--	--	--	--	--	--	--
gamma-BHC (Lindane)	--	--	--	--	--	--	--	--	--
Heptachlor	--	--	--	--	--	--	--	--	--
Aldrin	--	--	--	--	--	--	--	--	--
Heptachlor epoxide	--98 J	--51 J	--	--	--	--61 J	--	--	--
Endosulfan I	--	--	--	--	--	--	--	--	--
Dieldrin	--	--	--	--	--	--	--	--	--
4,4'-DDE									
Endrin	--	--	--	--	--	--	--	--	--
Endosulfan II	--	--	--	--	--	--	--	--	--
4,4'-DDD									
Endosulfan sulfate	--	--	--	--	--	--	--	--	--
4,4'-DDT									
Methoxychlor (Marlate)	--	--	--	--	--	--	--	--	--
Endrin Ketone	--	--	--	--	--	--	--	--	--

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TABLE 4-1
SUMMARY

SAMPLING POINT	K107S 6-14-89	K108 6-14-89	Blank 6-14-89						
N-Nitrosodiphenylamine	—	—	—	—	—	—	—	—	—
4-Bromophenyl-phenylether	—	—	—	—	—	—	—	—	—
Hexachlorobenzene	—	—	—	—	—	—	—	—	—
Pentachlorophenol	—	—	—	—	—	—	—	—	—
Phenanthrene	—15000	—110 J	—	—	—	—	—	—	—
Anthracene	—2200	—20 J	—	—	—	—	—	—	—
Di-n-Butylphthalate	—	—	—	—	—	—	—	—	—
Fluoranthene	—16,000	—210 J	—	—	—	—	—	—	—
Pyrene	—8800	—120 J	—	—	—	—	—	—	—
Butylbenzylphthalate	—	—	—	—	—	—	—	—	—
3,3'-Dichlorobenzidine	—	—	—	—	—	—	—	—	—
Benzo(a)anthracene	—10,000	—200 J	—	—	—	—	—	—	—
Chrysene	—7700	—170 J	—	—	—	—	—	—	—
bis(2-Ethylhexyl)phthalate	—	[illegible]	—100 J	—	—	—	—	—	—
Di-n-Octylphthalate	—	[illegible]	—	—	—	—	—	—	—
Benzo(b)fluoranthene	—8100	—	—	—	—	—	—	—	—
Benzo(k)fluoranthene	—6200	—	—	—	—	—	—	—	—
Benzo(a)pyrene	—6700	—	—	—	—	—	—	—	—
Indeno(1,2,3-cd)pyrene	—	—	—	—	—	—	—	—	—
Dibenz(a,h)anthracene	—	—	—	—	—	—	—	—	—
Benzo(g,h,i)perylene	—2400	—	—	—	—	—	—	—	—
cPAH's	38	0							
tPAH's (ppm)	91	0							

PESTICIDES									
alpha-BHC	—	—	—	—	—	—	—	—	—
beta-BHC	—	—	—	—	—	—	—	—	—
delta-BHC	—	—	—	—	—	—	—	—	—
gamma-BHC (Lindane)	—	—	—	—	—	—	—	—	—
Heptachlor	—	—	—	—	—	—	—	—	—
Aldrin	—	—	—	—	—	—	—	—	—
Heptachlor epoxide	—	—	—	—	—	—	—	—	—
Endosulfan I	—	—	—	—	—	—	—	—	—
Dieldrin	—	—	—	—	—	—	—	—	—
4,4'-DDE									
Endrin	—	—	—	—	—	—	—	—	—
Endosulfan II	—	—	—	—	—	—	—	—	—
4,4'-DDD									
Endosulfan sulfate	—	—	—	—	—	—	—	—	—
4,4'-DDT									
Methoxychlor (Marlate)	—	—	—	—	—	—	—	—	—
Endrin Ketone	—	—	—	—	—	—	—	—	—

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TABLE 4-1
SUMMARY

SAMPLING POINT	X101 6-14-89	X101S 6-14-89	X102 6-14-89	X103 6-14-89	X104 6-14-89	X105 6-14-89	X106 6-14-89	X106S 6-14-89	X107 6-14-89
alpha-Chlordane	--	--	--	--	--	--	--	--	--
gamma-Chlordane	--	--	--	--	--	--	--	--	--
Toxaphene	--	--	--	--	--	--	--	--	--
AROCLOR-1016	--	--	--	--	--	--	--	--	--
AROCLOR-1221	--	--	--	--	--	--	--	--	--
AROCLOR-1232	--	--	--	--	--	--	--	--	--
AROCLOR-1242	--	--	--	--	--	--	--	--	--
AROCLOR-1248	--	--	--	--	--	--	--	--	--
AROCLOR-1254	--	--	--	--	--	--	--	--	--
AROCLOR-1260	--	--	--	--	--	--	--	--	--
INORGANICS (ppm)									
ALUMINUM	2240	4390	1810	2100	4300	190	2390	3300	6200
ANTIMONY	0.4 u	0.3 u	0.4 u	0.4 u	1.0 B	43.1	1.1 B	0.3 u	0.6 B
ARSENIC	11.5	9.5	2.3	27.3	94	956	78.0	16.0	850
BARIUM	500	62.0	9.9 B	18.0 B	39.0	4.5 B	46.0	88.0	130
BERYLLIUM	2.0	1.8	0.8 B	1.2	2.6	0.6 B	3.2	10.0	11.0
CADMIUM	1.4	1.7	1.0	0.9 B	1.2	1.6	1.4	1.3	2.9
CALCIUM	47,100	12,900	21,700	26,700	66,500	[illegible]	9700	22,600	45,200
CHROMIUM	17.0	10.0	12.0	6.0	9.9	8.3	13.0	15.0	19.0
COBALT	8.8	6.1 B	3.2 B	3.7 B	5.2 B	1.5 B	4.1 B	4.6 B	6.3 B
COPPER	16.0	22.0	5.0	6.3	12.0	7.6	19.0	120	38.0
IRON	17,600	9300	3200	3500	14,800	490	2900	6300	23,200
LEAD	19.0	67.0	9.5	7.9	64.0	250	14.0	76.0	16.0
MAGNESIUM	21,500	2300	10,400	12,600	22,700	140	6500	19,000	17,700
MANGANESE	490	158	110	120	280	67.0	74.0	210	344
MERCURY	0.1	8.0	0.0 u	0.0 u	6.5	18.2	0.2	0.3	68.0
NICKEL	19.0	11.0	5.5 B	5.3 B	12.0	4.0 B	9.1	15.0	16.0
POTASSIUM	710 B	530 B	520 B	450 B	690 B	170 B	490 B	190 B	730
SELENIUM	0.2 u	0.9	0.2 u	0.8 B	0.6 B	2.0	14.1	0.5 B	1.3
SILVER	0.8 B	0.5 B	1.3 B	0.9 B	0.1	1.4	2.0	1.4 B	1.9
SODIUM	280 B	195 B	190 B	210 B	220 B	46.0 B	300 B	790 B	360
THALLIUM	0.2 u	0.3 B	0.2 u	0.2 u	0.1 u	0.2 u	0.2 u	0.1 u	0.2 B
VANADIUM	26.0	15.0	9.7 B	11.0	14.0	2.1 B	15.0	13.0	18.0
ZINC	400	66.0	30.0	20.0	96.0	9.9	30.0	910	190
CYANIDE	0.8 u	2.4	0.5 u	0.4 u	47.0	656	6.9	0.6 u	4.8
SULFATE	--	--	--	--	--	--	--	--	--
SULFIDE	--	--	--	--	--	--	--	--	--

PUT SITE NAME HERE
PUT USEPA NUMBER HERE

TABLE 4-1
SUMMARY

SAMPLING POINT	X107S 6-14-89	X108 6-14-89	BLANK 6-14-89						
alpha-Chlordane	—	—	—	—	—	—	—	—	—
gamma-Chlordane	—	—	—	—	—	—	—	—	—
Toxaphene	—	—	—	—	—	—	—	—	—
AROCLOR-1016	—	—	—	—	—	—	—	—	—
AROCLOR-1221	—	—	—	—	—	—	—	—	—
AROCLOR-1232	—	—	—	—	—	—	—	—	—
AROCLOR-1242	—	—	—	—	—	—	—	—	—
AROCLOR-1248	—	—	—	—	—	—	—	—	—
AROCLOR-1254	—	—	—	—	—	—	—	—	—
AROCLOR-1260	—	—	—	—	—	—	—	—	—
INORGANICS									
ALUMINUM	1500	2400	26.0 B	—	—	—	—	—	—
ANTIMONY	0.5 B	0.3 U	0.4 U	—	—	—	—	—	—
ARSENIC	32.0	3.8	0.2 U	—	—	—	—	—	—
BARIUM	26.0	15.0 B	0.3 U	—	—	—	—	—	—
BERYLLIUM	7.6	2.9	0.1 U	—	—	—	—	—	—
CADMIUM	2.1	1.9	0.2 U	—	—	—	—	—	—
CALCIUM	33500	26300	27.4 U	—	—	—	—	—	—
CHROMIUM	17.0	10.0	0.6 U	—	—	—	—	—	—
COBALT	6.4 B	4.0 B	0.6 BB	—	—	—	—	—	—
COPPER	36.0	8.7	0.6 B	—	—	—	—	—	—
IRON	21,600	3700	7.4 U	—	—	—	—	—	—
LEAD	910	40.0	2.6 U	—	—	—	—	—	—
MAGNESIUM	13,000	4,000	18.4 U	—	—	—	—	—	—
MANGANESE	500	130	0.2 U	—	—	—	—	—	—
MERCURY	33.0	0.0 U	0.0 U	—	—	—	—	—	—
NICKEL	150	8.8	1.1 B	—	—	—	—	—	—
POTASSIUM	570 B	420 B	[illegible] U	—	—	—	—	—	—
SELENIUM	0.6 B	0.2 U	0.2 U	—	—	—	—	—	—
SILVER	1.4 B	0.7 B	0.9 B	—	—	—	—	—	—
SODIUM	540 B	340 B	330 B	—	—	—	—	—	—
THALLIUM	0.3 B	0.1 U	0.2 U	—	—	—	—	—	—
VANADIUM	16.0	9.4	0.4 B	—	—	—	—	—	—
ZINC	128	50.0	2.2 U	—	—	—	—	—	—
CYANIDE	3.1	0.7 U	10.0 U	—	—	—	—	—	—
SULFATE	—	—	—	—	—	—	—	—	—
SULFIDE	—	—	—	—	—	—	—	—	—

ORGANIC DATA QUALIFIERS

U - Indicates compound was analyzed for but not detected.

J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.

C - This flag applies to pesticide results where the identification has been confirmed by GC/MS.

B - This flag is used when the analyte is found in the associated blank as well as in the sample.

E - This flag identifies compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis. This flag will not apply to pesticide/PCB's analyzed by GC/EC methods.

D - This flag identifies all compounds identified in an analysis at a secondary dilution factor.

A - This flag indicates that a TIC is a suspected aldol-condensation product.

X - Other specific flags and footnotes may be required to properly define the results. If used, they must be fully described and such description attached to the Sample Data Summary Package and the Case Narrative.

INORGANIC DATA QUALIFIERS

C (Concentration) Qualifier:

B - Indicates the reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).

U - Indicates compound was analyzed for but not detected.

Q Qualifier:

E - The reported value is estimated because of the presence of interference.

M - Duplicate injection precision not met.

N - Spiked sample recovery not within control limits.

S - The reported value was determined by the Method of Standard Additions (MSA).

W - Post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while the sample absorbance is less than 50% of spike absorbance.

* - Duplicate analysis not within control limits.

+ - Correlation coefficient for the MSA is less than 0.995.

M (Method) Qualifier Enter:

- "P" for ICP
- "A" for Flame AA
- "F" for Furnace AA
- "CV" for Manual Cold Vapor AA
- "AV" for Automated Cold Vapor AA
- "AS" for Semi-Automated Spectrophotometric
- "C" for Manual Spectrophotometric
- "T" for Titrimetric
- "NR" if the analyte is not required to be analyzed.

Appendix K

Laboratory Standard Operating Procedures
Additional Parameters

METHOD	METHOD REFERENCE
ALKALINITY	EPA 310.1
ACIDITY	EPA 305.1
AMMONIA NITROGEN	EPA 350.2
ARSENIC (III) AND ARSENIC (V)	USGS
BOD	EPA 405.1
CATION-EXCHANGE CAPACITY OF SOILS	EPA9081
CHLORIDE	EPA 407 B
COD	EPA 410.4
pH	EPA 150.1
SULFATE	EPA 375.4
SULFIDE	EPA 376.1
TOTAL HARDNESS	EPA 130.2
TOTAL DISSOLVED SOLIDS	EPA 160.1
TOTAL ORGANIC CARBON	EPA 415.1
THIOCYANATE	SM 4500-CN-M
TOTAL AND AMENABLE CYANIDE	EPA 9010A/9012A
WEAK ACID DISSOCIABLE CYANIDE	SM 4500-CN-I

ALKALINITY

Method 310.1 (Titrimetric, pH 4.5)

Optimum Concentration Range:
Sensitivity:
Approximate Detection Limit:
LIMS Test Code: **ALK**
EPA Holding Time: 14 **Days**

1.0 Method Summary:

An unaltered sample is titrated to an electrometrically determined end point of pH 4.5. The sample must not be filtered, diluted, concentrated, or altered in any way.

2.0 Bench Sheets:

Fill out the **ALKALINITY** bench sheet before beginning any analyses. Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. As the analysis proceeds, problems, titration values, and other information are written on the bench sheet immediately. The analyst must initial and date the bench sheet when the sample run is completed.

3.0 Spreadsheet:

All sample data and QC data should be entered into the ALKALINITY computer spreadsheet program within 24 hours after the analysis is completed. All calculations, whether manual or by computer, must be completed within 24 hours after analysis is completed as well. Date and initial the bench sheet when the data is entered into the spreadsheet program. Results will be copied onto the bench sheets where appropriate, to facilitate entry of data into LIMS. When bench sheets are completed, a copy is made for each sample group or client represented in the analytical run. Client/sample names are highlighted. The original bench sheet is placed into the parameter binder with other information. Copies for each client are included with the client- or sample-specific file, to facilitate the final review of a specific client's samples before the report is issued to the client.

When all sample and QC data have been entered, all calculations have been made, and the spreadsheet information has been saved to disk, the analyst will print hard copies of the related analytical data, control charts, and other pertinent areas of the spreadsheet. These hard copies will be initialled, and clipped to the original bench sheet. The analyst will review the data according to section 6 in the SOP manual. This review should be done within 24 hours of the analysis. When the analyst has completed the review, the data packet is placed into the parameter binder in the laboratory with the time noted on the bench sheet.

4.0 Data Review Process:

After the data review process has been completed (see Section 6 of the SOP Manual), within 24 hours it is the responsibility of the analyst to enter the data into LIMS or have a data-entry clerk enter the data into LIMS. The person who enters the data will initial and date the bench sheet with a time, and the binder will be returned to the laboratory.

5.0 Quality Control Samples:

For ALKALINITY analyses, the following control samples are included on the bench sheet and should be run with each batch of samples:

* method blank
* QC check sample
* duplicate samples

Acceptance limits for these quality control samples are as follows:

* method blank - The analyst should run a sample of distilled, deionized water through the procedure as indicated, and use this as a comparison sample for the "blank." Values for pH and alkalinity of the water can be entered on a spreadsheet to document the reproducibility of the procedure and the

quality of the water being used for analyses in the wet chemistry section.

* QC check sample - The spreadsheet has an area for entering data from the QC check sample. True value is given and the % recovery is calculated. This is charted on a control chart and statistical information is generated. The recovery on the QC sample must be within $\pm$ 3S for acceptance. When the QC recovery is outside this range, the system must be checked, a new QC sample made up, and the associated batch of samples must be re-analyzed. This must be documented on a corrective action report.

* duplicate samples - Generally an RPD of 20 is considered the outside limit. The spreadsheet has an area for entry of duplicate analysis data. This will be charted after each analytical run. Acceptance limits are RPD inside + 3S.

6.1 **Apparatus:**

a. pH meter or electrically operated titrator that uses a glass electrode and can be read to 0.05 pH units.

b. Appropriate glass vessels to keep the air space above the solution at a minimum.

c. Magnetic stirrer, pipets, standard laboratory equipment.

d. Burets, pyrex, 50, 25, 10 mL.

6.2 **Reagents:**

a. Sodium carbonate solution, approximately 0.05 N: Place 2.5 g (to nearest mg) Na_2CO_3 (dried at 250°C for 4 hours and cooled in desiccator) into a 1 L volumetric flask and dilute to the mark.

b. Standard acid (sulfuric or hydrochloric), 0.1 N: Dilute 3.0 mL concentrated H_2SO_4 or 8.3 mL concentrated HCl to about 1 L with distilled water.

1) Standardize versus 40.0 mL of 0.05 N Na_2CO_3 solution with about 60 mL distilled water.

2) Titrate potentiometrically to pH of about 5. Lift electrode and rinse into beaker. Boil solution gently for 3-5 minutes under a watch glass cover. Cool to room temperature. Rinse cover glass into beaker. Continue titration to the pH inflection point.

3) Calculate normality by using:

$$N = \frac{A \times B}{53.00 \times C}$$

where A = g Na_2CO_3 weighed in 1 L
B = ml Na_2CO_3 solution
C = ml acid used to inflection point

c. Standard acid (sulfuric or hydrochloric), 0.02 N: Dilute 200.0 mL of 0.1000 N standard acid to 1 L with distilled water. Standardize by potentiometric titration of 15.0 mL and 0.05 N Na_2CO_3 solution as above.

6.3 Procedure:

a. The pH meter must be calibrated before running this analysis. Check the calibration log for the pH meter to determine if the meter has been calibrated on this date. If not, calibrate the meter using the SOP for pH, found in this SOP manual.

b. Sample size:

1) Use a sufficiently large volume of titrant (>20 mL in a 50 mL buret) to obtain good precision while keeping volume low enough to permit sharp end point.

2) For <1000 mg $CaCO_3$/L use 0.02 N titrant.

3) For >1000 mg $CaCO_3$/L use 0.1 N titrant.

c. Potentiometric titration:

1) Place sample in flask by pipetting with pipet tip near bottom of flask.

2) Measure and record pH of sample.

3) Add standard acid, being careful to stir thoroughly but gently to allow needle to obtain equilibrium.

4) Titrate to pH 4.5. Record volume of titrant.

d. Potentiometric titration of low alkalinity:

1) For alkalinity of <20 mg/L titrate 100-200 mL as above using a 10 mL microburet and 0.02 N acid solution.

2) Stop titration at pH in range of 4.3-4.7, record volume and exact pH. Very carefully add titrant to lower pH by exactly 0.3 pH units. Record volume of titrant.

6.4 Calculation:

a. Potentiometric titration to pH 4.5:

$$\text{alkalinity, mg/L } CaCO_3 = \frac{A \times N \times 50\,000}{\text{mL of sample}}$$

where: A = mL standard acid
N = normality standard acid

b. Potentiometric titration of low alkalinity:

$$\text{alkalinity, mg/L } CaCO_3 = \frac{(2B - C) \times N \times 50\,000}{\text{mL of sample}}$$

where: B = mL titrant to first recorded pH
C = total mL titrant to reach pH exactly 0.3 pH units lower
N = normality of acid

6.4 Reporting:

a. Alkalinity is reported in units of mg/L $CaCO_3$.

7.0 Notes:

7.1. This method is suitable for all concentration ranges of alkalinity. However, appropriate aliquots should be used to avoid a titration volume greater than 50 mL.

7.2. The sample must not be filtered, diluted, concentrated, or altered in any way.

7.3. The sample should be refrigerated at 4°C and run as soon as possible. Do not open the sample bottle before analysis.

7.4. For samples having high concentrations of mineral acids, such as mine wastes and associated receiving waters, titrate to an electrometric endpoint of pH 3.9.

7.5. Oil and grease, by coating the pH electrode, may also interfere, causing sluggish response.

ACIDITY

Method 305.1 (Titrimetric)

Optimum Concentration Range:
Sensitivity:
Approximate Detection Limit:
LIMS Test Code: ACID
EPA Holding Time: 14 Days

1.0 Method Summary:

The pH of the sample is determined and a measured amount of standard acid is added, as needed, to lower the pH to 4 or less. Hydrogen peroxide is added, the solution boiled for several minutes, cooled, and titrated electrometrically with standard alkali to pH 8.2.

2.0 Bench Sheets:

Fill out the ACIDITY bench sheet before beginning any analyses. Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. As the analysis proceeds, problems, titration values, and other information are written on the bench sheet immediately. The analyst must initial and date the bench sheet when the sample run is completed.

3.0 Spreadsheet:

All sample data and QC data should be entered into the ACIDITY computer spreadsheet program within 24 hours after the analysis is completed. All calculations, whether manual or by computer, must be completed within 24 hours after analysis is completed as well. Date and initial the bench sheet when the data is entered into the spreadsheet program. Results will be copied onto the bench sheets where appropriate, to facilitate entry of data into LIMS. When bench sheets are completed, a copy is made for each sample group or client represented in the analytical run. Client/sample names are highlighted. The original bench sheet is placed into the parameter binder with other information.

Copies for each client are included with the client- or sample-specific file, to facilitate the final review of a specific client's samples before the report is issued to the client.

When all sample and QC data have been entered, all calculations have been made, and the spreadsheet information has been saved to disk, the analyst will print hard copies of the related analytical data, control charts, and other pertinent areas of the spreadsheet. These hard copies will be initialled, and clipped to the original bench sheet. The analyst will review the data according to section 6 in the SOP manual. This review should be done within 24 hours of the analysis. When the analyst has completed the review, the data packet is placed into the parameter binder in the laboratory with the time noted on the bench sheet.

4.0 Data Review Process:

After the data review process has been completed (see Section 6 of the SOP), within 24 hours it is the responsibility of the analyst to enter the data into LIMS or to have a data-entry clerk enter the data into LIMS. The person who enters the data will initial and date the bench sheet with a time, and the binder will be returned to the laboratory.

5.0 Quality Control Samples:

For ACIDITY analyses, the following control samples are included on the bench sheet and should be run with each batch of samples:

* method blank
* QC check sample
* duplicate samples

Acceptance limits for these quality control samples are as follows:

* method blank - The analyst should run a sample of distilled, deionized water through the procedure as indicated, and use this as a comparison sample for the "blank." Values for pH and acidity of the water can be entered on a

spreadsheet to document the reproducibility of the procedure and the quality of the water being used for analyses in wet chemistry.

* QC check sample - The spreadsheet has an area for entering data from the QC check sample. True value is given and the % recovery is calculated. This is charted on a control chart and statistical information is generated. The recovery on the QC sample must be within ± 3S for acceptance. When the QC recovery is outside this range, the system must be checked, a new QC sample made up, and the associated batch of samples must be re-analyzed. This must be documented on a corrective action report.

* duplicate samples - Generally an RPD of 20 is considered the outside limit. The spreadsheet has an area for entry of duplicate analysis data. This will be charted after each analytical run. Acceptance limits are RPD inside + 3S.

6.1 **Apparatus:**

a. pH meter, suitable for electrometric titrations

b. ordinary laboratory glassware

6.2 **Reagents:**

a. Hydrogen peroxide (H_2O_2, 30% solution): Available commercially.

b. Standard sodium hydroxide, 0.02 N: Dissolve 8 g NaOH in distilled water in a 1000 mL volumetric flask. Mix thoroughly, cool, and dilute to volume with distilled water.

c. Standard sulfuric acid, 0.02 N: Add 5.6 mL concentrated sulfuric acid to water in a 1000 mL volumetric flask. Dilute to volume and mix well.

6.3 Procedure:

a. The pH meter must be calibrated before this analysis is begun. Check the calibration log for this date to see that the pH meter has been calibrated today. If not, calibrate using the SOP for pH, located in the SOP Manual.

b. Pipet 50 mL of the sample into a 250 mL beaker.

c. Measure the pH of the sample. If the pH is above 4.0, add standard sulfuric acid in 5.0 mL increments to lower the pH to 4.0 or less. If the initial pH is less than 4.0, the incremental addition of sulfuric acid is not required.

d. Add 5 drops hydrogen peroxide solution.

e. Heat the sample to boiling and continue boiling for 2 to 4 minutes. In some instances the concentration of ferrous iron is such that an additional amount of hydrogen peroxide and a slightly longer boiling time may be required.

f. Cool the sample to room temperature and titrate electrometrically with standard sodium hydroxide to pH 8.2.

6.4 Calculation:

a. Acidity as mg/L $CaCO_3$ = $\frac{[(A \times B) - (C \times D)] \times 50\,000}{\text{mL of sample}}$

where: A = vol.std. NaOH used in titration
B = normality of std. NaOH solution
C = vol.std. sulfuric acid used to produce pH <4.0
D = normality of std. sulfuric acid

b. If it is desired to report acidity in milliequivalents per liter, the reported values as $CaCO_3$ are divided by 50.

6.5 **Reporting:**

a. Acidity is reported in units of mg/L $CaCO_3$

b. Reporting limits: Values below 10 mg/L are reported as <10.

7.0 **Notes:**

7.1. The method covers the range from approximately 10 mg/L acidity to approximately 1000 mg/L as $CaCO_3$ using a 50 mL sample.

7.2. The method measures the mineral acidity of a sample plus the acidity resulting from oxidation and hydrolysis of polyvalent cations, including salts of iron and aluminum.

7.3. Suspended matter present in the sample, or precipitates formed during the titration may cause a sluggish electrode response. This may be offset by allowing a 15-20 second pause between additions of titrant or by slow dropwise addition of titrant as the endpoint pH is approached.

NH3
(Nitrogen, Ammonia)

Method 350.2 (Titrimetric Procedure - Distillation)

Optimum Concentration Range:
Sensitivity:
Approximate Detection Limit:
LIMS Test Code: **NH3**
Holding Time: **28 Days**

1.0 Method Summary:

The sample is buffered at a pH of 9.5 with a borate buffer in order to decrease hydrolysis of cyanates and organic nitrogen compounds, and is then distilled into a solution of boric acid. The ammonia in the distillate is determined titrimetrically with standard sulfuric acid with the use of a mixed indicator.

2.0 Bench Sheets:

Fill out the **NH3-AMMONIA** bench sheet before beginning any analyses. Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. As the analysis proceeds, problems, variations, and other information are written on the bench sheet immediately. The analyst must initial and date the bench sheet when the sample run is set up and when the run is completed.

3.0 Spreadsheet:

All sample data and QC data should be entered into the NH3-AMMONIA computer spreadsheet program within 24 hours after the analysis is completed. Calculations can be done manually or by use of the computer program. Date and initial the bench sheet when the data is entered into the spreadsheet program. When all QC data have been entered, all calculations have been made, and the spreadsheet information has been saved to disk, the analyst will print hard copies of the related control charts, and other pertinent areas of the spreadsheet. These hard copies will be initialled, and clipped to the original bench sheet.

When bench sheets are completed, the analyst will make copies for each client/sample group represented in the analytical run. The original bench sheet is put into the parameter binder with other pertinent information, for data review and for data entry. Copies are filed with client- or sample-specific files, to facilitate the final review of the final report for a client or sample group.

The analyst then reviews the data according to section 6 in the SOP manual. This review should be done within 24 hours of the analysis. When the analyst has completed the review, the data packet is placed in the parameter binder in the laboratory with the time noted on the bench sheet.

4.0 Data Review Process:

After the data review process has been completed (see Section 6 of the SOP Manual), within 24 hours, it is the responsibility of the analyst to enter the data into LIMS or to have the data-entry clerk enter the data into LIMS. The person who enters the data will initial and date the bench sheet, with a time, and the binder will be returned to the laboratory.

5.0 Quality Control Samples:

For NH3-AMMONIA analyses, the following control samples are included on the bench sheet and should be run with each batch of samples:

* method blank
* QC check sample
* duplicate samples

Acceptance limits for these quality control samples are as follows:

* method blank - if the analyte of interest is detected in the method blank, any sample in which the analyte is present at < 10X the level detected in the blank must be re-analyzed. The spreadsheet has a section for entering blank result data.

* QC check sample - The spreadsheet has an area for entering data from the QC check sample. True value is given and the % recovery is calculated. This is charted on a control chart and statistical information is generated. The recovery on the QC sample must be within $\pm$ 3S for acceptance. When the QC recovery is outside this range, the system must be checked, a new QC sample made up, and the associated batch of samples must be re-analyzed. This must be documented on a corrective action report.

* duplicate samples - Generally an RPD of 20 is considered the outside limit. The spreadsheet has an area for entry of duplicate analysis data. This will be charted after each analytical run. Acceptance limits are RPD inside + 3S.

6.0 Analytical Procedure:

6.1 Apparatus:

a. An all-glass distilling apparatus with an 800-1000 mL flask.

b. Erlenmeyer flasks: The distillate is collected in 500 mL glass-stoppered flasks. These flasks should be marked at the 350 mL and 500 mL volumes. With such markings, it is not necessary to transfer the distillate to volumetric flasks.

6.2 Reagents:

a. Distilled water should be free of ammonia. All solutions should be made with ammonia-free water.

b. Ammonium chloride, stock solution: 1.0 mL = 1.0 mg NH_3-N: Dissolve 3.819 g NH_4Cl in distilled water and bring to volume in a 1 L volumetric flask.

c. Ammonium chloride, standard solution: 1.0 mL = 0.01 mg: Dilute 10.0 mL of stock solution to 1 L in a volumetric flask.

d. Boric acid solution (20g/L): Dissolve 20 g H_3BO_3 in distilled water and dilute to 1 L.

e. Mixed indicator: Mix 2 volumes of 0.2% methyl red in 95% ethyl alcohol with 1 volume of 0.2% methylene blue in 95% ethyl alcohol. This solution should be prepared fresh every 30 days.

g. Borate buffer:

   1) Sodium tetraborate solution, 0.025 M: Add 5.0 g anhydrous sodium tetraborate or 9.5 g hydrated sodium tetraborate to 1 L water.

   2) Add 88 mL of 0.1 N NaOH solution to 500 mL of 0.025 M sodium tetraborate solution and dilute to 1 L with distilled water.

h. Sulfuric acid, standard solution, 0.02 N; (1 mL = 0.28 mg NH3-N):

   1) Prepare a stock solution of approximately 0.1 N acid by diluting 3 mL of concentrated H_2SO_4 to 1 L with CO_2-free distilled water. Dilute 200 mL of this solution to 1 L with CO_2-free distilled water.

   2) Standardize the acid against the Na_2CO_3 solution. See i, below.

i. Na_2CO_3, 0.0200 N: Dissolve 1.060 g anhydrous Na_2CO_3, oven-dried at 140°C, and dilute to 1 L with CO_2-free distilled water.

j. Sodium hydroxide, 1 N: Dissolve 40 g NaOH in ammonia-free water and dilute to 1 L.

k. De-chlorinating agents: Dissolve 3.5 g sodium thiosulfate in distilled water and dilute to 1 L.

   1 mL of this solution will remove 1 mg/L of residual chlorine in 500 mL of sample.

6.3 Procedure:

6.3.1 Preparation of equipment:

1) Add 500 mL of distilled water to an 800 mL Kjeldahl flask. The addition of boiling chips which have been previously treated with dilute NaOH will prevent bumping.

2) Steam out the distillation apparatus until the distillate shows no trace of ammonia with Nessler reagent.

6.3.2 Sample preparation:

1) Remove the residual chlorine in the sample by adding dechlorinating agent equivalent to the chlorine residual.

2) To 400 mL of sample, add 1 N NaOH until the pH is 9.5, checking the pH during addition with a pH meter or by use of short-range pH paper.

6.3.3 Distillation:

1) Transfer the sample, the pH of which has been adjusted to 9.5, to an 800 mL Kjeldahl flask and add 25 mL of the borate buffer. Distill 300 mL at the rate of 6-10 mL/minute into 50 mL of 2% boric acid contained in a 500 mL Erlenmeyer flask.

2) The condenser tip or an extension of the tip must extend below the level of the boric acid solution.

6.3.4 Determination of ammonia in distillate:

1) Determine the ammonia content of the distillate titrimetrically.

2) Add 3 drops of the mixed indicator to the distillate and titrate the ammonia with the 0.02 N H_2SO_4, matching the end point against a blank containing the

same volume of distilled water and H_3BO_3 solution.

6.3.5 Standards:

1) It is not necessary that all standards be distilled in the same manner as the samples.

2) It is recommended that at least two standards, low and high, be distilled and compared to similar values on the curve to insure that the distillation technique is reliable.

6.4 Calculation: For titrimetric determinations:

$$\text{mg/L } NH_3\text{-N} = \frac{A \times 0.28 \times 1000}{S}$$

where: A = mL 0.02 N H_2SO_4 used
S = mL sample

7.0 Reporting:

a. Ammonia-nitrogen is reported in units of mg/L.

b. Values below 0.1 mg/L are reported as <0.1.

8.0 Notes:

8.1 The method covers the range from about 0.05 to 1.0 mg NH3-N/L for the titrimetric procedure.

8.2 Samples may be preserved with 2 mL concentrated H_2SO_4 per liter and stored at 4°C.

8.3 Cyanate will hydrolyze to some extent, even at pH of 9.5.

8.4 Residual chlorine must be removed by pretreatment of the sample with sodium thiosulfate before distillation.

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STANDARD OPERATING PROCEDURE

SEPARATION PROCEDURE FOR ARSENIC (III) AND ARSENIC (V) IN GROUND WATER AND SURFACE WATER

METHOD REFERENCE

Walter H. Ficklin, Separation of Arsenic (III) and Arsenic (V) in Ground Water and Surface Water, Talanta, Vol. 30, No. 5, 1983.

Reagents:

1. Hydrochloric Acid (HCL) concentrated, "Baker Analyzed" Reagent grade JT9535-33
2. Glacial Acetic acid, VWR Reagent ACS VW0125-3
3. Sodium Hydroxide, EM Science Reagent Grade, Solid pellets, EM-SX0590-3
4. Sodium Arsenite, Baker Analyzed, Solid Crystal, JT3487-04
5. Sodium Arsenate-Dibasic, 7-Hydrate, Granular, Baker Analyzed JT3486-04
6. Nickel Standard, 1000 ppm, EM Science Lot 8210, used for Modifier JT2784-1
7. Nanopure deionized water
8. Ion exchange resin: Dowex 1X8 anion (100-200 mesh) Bio-Rad P/N745-1441

Apparatus:

Resin columns: Glass econo-columns, 10 cm X 7 mm disposable; Bio-Rad P/N737-0710

Test Tubes: Glass, 12 ml VWR 60825-630

Chemical Preparation:

1. To prepare 0.12 M HCL, add 10 ml of conc HCL to a 1 liter volumetric flask and dilute to mark with nanopure deionized water.
2. To prepare 1 M NaOH, add 40.0 gms of Sodium Hydroxide to a 1 liter volumetric flask and dilute to mark with nanopure deionized water.

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3. To prepare 1 M Acetic Acid, add 57.5 mls of Reagent grade Glacial Acetic Acid to a 1 liter volumetric flask and dilute to 1 liter with nanopure deionized water.

4. To prepare a 1000 ppm solution of As (III), add 1.7339 gms of Sodium Arsenite ($NaAsO_2$) to a 1 liter volumetric flask, add 900 ml nanopure water to dissolve, 10 ml of conc HCL to preserve and then dilute to 1 liter with nanopure deionized water.

5. To prepare a 1000 ppm solution of As (V), dissolve 4.1645 gms of Sodium Arsenate-Dibasic, 7-Hydrate in a 1 liter flask with 900 mls of nanopure water, preserve with 10 ml of conc HCL and dilute to 1 liter with nanopure deionized water.

Column Preparation:

1. To prepare the columns for Arsenic separation, weigh out 2.3 grams of Bio-Rad Dowex 1X8 anion-resin, 100-200 mesh.

2. Slurry pack the resin with nanopure water into Bio-Rad 10 cm X 7 mm disposable econo-columns.

3. Convert the resin to the acetate form by adding 3 mls of 1M NaOH and allow to drain through the column, followed by 15 mls of nanopure deionized water rinse.

4. Then add 5 ml of 1M Acetic Acid and allow to drain through the column, followed by a final 15 ml nanopure deionized water rinse.

5. Columns are then capped while still wet to keep moist and dust free.

Separation Procedure:

1. Acidify 100 mls of 0.45 micron filtered samples with 1 ml of conc HCL.

2. To separate the samples for Arsenic (III) and (V), uncap the prepared columns and add 5 ml of acidified sample and allow to drain from the column into a 12 ml glass test tube.

3. Next add 5 ml of 0.12 M HCL to the column, allow to drain, and collect in the test tube containing the eluted 5 ml sample.

4. Remove the test tube, cap, mix and save as fraction 1 for Arsenic (III) analysis.

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5. Repeat by adding 2-5 ml portions of 0.12 M HCL to the column and collect both elutriates together in a second tube for analysis.

6. Cap and mix the second tube, then label as fraction 2 for Arsenic (V) analysis.

Quality Control:

1. Preparation blanks of 0.12M HCL are passed through the procedure exactly as the samples at 1 in 20.

2. Column performance is monitored by passing of 5 mls of mixed standard at 20 ug/l of both As (III) and As (V) through the procedure exactly as the samples. 50 µg/L

3. Duplicate samples are speciated and analyzed at 1 in 20.

4. Matrix spikes at 20 ug/l of both As (III) and As (V) of a mixed standard are prepared and analyzed exactly as the samples at 1 in 20.

Analysis:

Analyze the fractions by Zeeman graphite furnace atomic absorption spectroscopy using EPA method 206.2, 600/4-79-020.

TOTAL P.07

40

SEPARATION OF ARSENIC(III) AND ARSENIC(V) IN GROUND WATERS BY ION-EXCHANGE

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(*Received 17 August 1982. Accepted 5 November 1982*)

Summary—*The predominant species of arsenic in ground water are probably arsenite and arsenate. These can be separated with a strong anion-exchange resin (Dowex 1 × 8; 100–200 mesh, acetate form) in a 10 cm × 7 mm column. Samples are filtered and acidified with concentrated hydrochloric acid (1 ml per 100 ml of sample) at the sample site. Five ml of the acidified sample are used for the separation. At this acidity, As(III) passes through the acetate-form resin, and As(V) is retained. As(V) is eluted by passage of 0.12M hydrochloric acid through the column (resulting in conversion of the resin back into the chloride form). Samples are collected in 5-ml portions up to a total of 20 ml. The arsenic concentration in each portion is determined by graphite-furnace atomic-absorption spectrophotometry. The first two fractions give the As(III) concentration and the last two the As(V) concentration. The detection limit for the concentration of each species is 1 µg/l.*

Arsenic in ground waters occurs in the oxidation states As(III) and As(V). Recently Cherry *et al.*[1] proposed that the concentrations of As(III) and As(V) could be used to calculate the oxidation-reduction potential of a ground water sample. The redox potential is an important factor in the study of ground waters as a sample medium for geochemical exploration.

A popular method[2,3] for determining low levels of As(III) and As(V) involves generation of arsine, coupled with atomic-absorption detection. Careful control of sample pH is required in order to generate arsine selectively from As(III).[2,3] The sample must also be analysed very soon after collection or stabilized in some way to prevent oxidation of As(III). Acidification with hydrochloric acid prevents the oxidation[4] but the pH must then be carefully adjusted before the analysis. Nakashima[5] added Zr(IV) and potassium iodide to the acidified sample to generate arsine selectively from As(III). All the methods require complex equipment and procedures.

A simple separation of As(III) and As(V) based on ion-exchange is presented here. The sample can be stored in acidified solution or the separation can be performed at the sample site before any chemical change can take place. The use of an anion-exchange resin for separation of arsenic species in water has been investigated by Henry and Thorpe,[6] but they used separate portions of sample water for determination of As(III) and As(V). Pacey and Ford used a similar ion-exchange method to determine organic and inorganic arsenic species,[7] with detection by graphite-furnace atomic-absorption spectrophotometry (GFAAS).

GFAAS determination of arsenic, with addition of nickel, is well established.[8] Small volumes of sample are required and a detection limit of 1 µg/l. is readily achieved. GFAAS was therefore chosen for the determinations in the present work.

EXPERIMENTAL

Apparatus

A Perkin-Elmer model 703 atomic-absorption spectrophotometer* equipped with a deuterium arc background corrector and an HGA-2200 graphite furnace was used for arsenic determination. Glass "econo-columns" were obtained from Bio-Rad Laboratories (Richmond, California). The samples were injected manually by Eppendorf pipette or with a Perkin-Elmer As-1 autosampler.

Reagents

Hydrochloric acid, nitric acid, acetic acid, sodium arsenite, disodium hydrogen arsenate heptahydrate, sodium hydroxide and nickel nitrate 6-hydrate were "Baker Analysed", supplied by J. T. Baker Chemical Co. Dowex 1 × 8 anion-exchange resin (100–200 mesh) was supplied by Bio-Rad Laboratories. Demineralized water was obtained from a Millipore Milli-Q water system.

Column preparation

Glass "econo-columns" (10 cm × 7 mm) were used for all separations. Enough resin (2.3 g) was slurry-packed into the column to fill it to within 1 or 2 mm of the top. The resin was supplied in the chloride form and required conversion into the acetate form through the hydroxide form as intermediate. This was achieved by allowing 3 ml of 1*M* sodium hydroxide to drain through the resin, followed by 15 ml of water and then 5 ml of 1*M* acetic acid. The resin was rinsed once more with water, leaving the resin in the acetate form. A small amount of water was added to the columns to keep the resin moist. The columns were capped to prevent contamination from dust.

Procedure

At the sample site, 50 ml of water were filtered through a 0.45-µm membrane filter (to remove particulate matter that might contain soluble or acid-leachable arsenic), and

*Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

Table 1. Instrumental parameters for graphite-furnace atomic-absorption spectrometer

Drying	60 sec	100 C	
Charring	20 sec	950 C	
Atomizing	6 sec	2700 C	Interrupt mode
Purge gas	Argon		
Source	Electrodeless discharge lamp		

then acidified with 0.5 ml of concentrated hydrochloric acid. Five ml of the acidified sample were allowed to pass through the resin in the column, followed by 15 ml of 0.12M hydrochloric acid as eluent, added in three separate 5-ml portions. The successive 5-ml fractions of effluent (one from the sample, three from the eluent) were collected in 6-ml vials, which were then capped. The As(III) from the sample was in the first two fractions and the As(V) in the last two.

Table 2. Results for arsenic speciation in ground waters and acid mine waters

Sample	As(III), μg/l.	As(V), μg/l.	Total As, μg/l.
M002*	23	7	30
M021*	<1	3	3
M022*	2	5	7
M027*	1	18	18
M030*	2	6	8
M043	1	6	8
M045*	54	16	69
BV-012*	8	6	14
BV-020*	2	4	5
BV-039*	<1	5	5
BV-041*	<1	5	5
BV-046*	1	10	11
MS-02†	13	1	15
MS-03†	5	2	7
MS-04†	5	2	7
MS-06†	5	1	6
MS-08†	4	1	6
Salt Spring, Utah	1400	1180	2450

*Irrigation well water, Beaver Area, Utah.
†Acid mine water, Colorado.

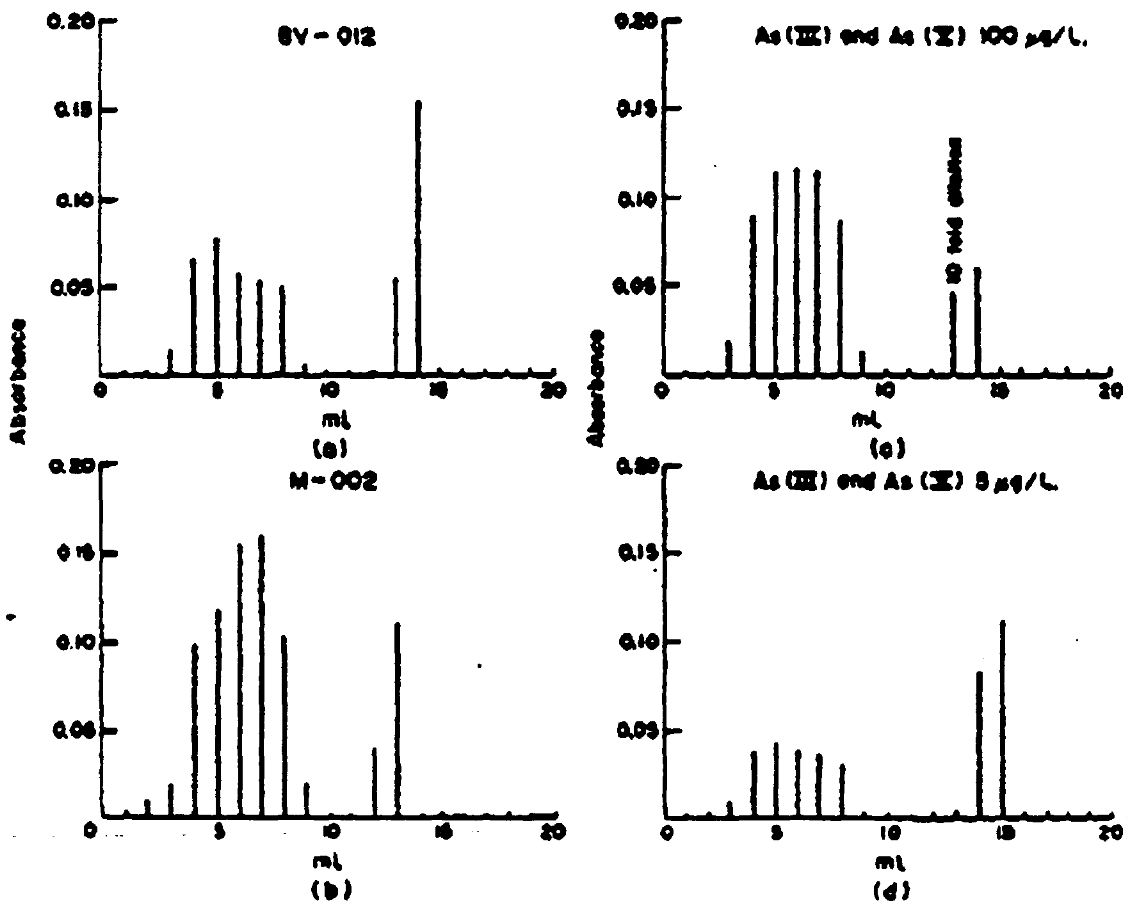

Fig. 1. Separation of As(III) and As(V): a, b, d, 25-μl samples, interrupted mode; [illegible]

Table 3. Recovery of added arsenic

Sample	As(III), µg/l.	As(V), µg/l.	As(III),* µg/l.	As(V),* µg/l.
M-027	1	18	6	24
BV-012	6	5	12	10
BV-041	<1	5	5	11
BV-046	1	10	7	16
Virginia Canyon Mine	2	1	6	6
Lucania Mine	1	<1	6	6

*Spiked with 5 µg of arsenic per litre.

Table 4. Sample-site separation compared to laboratory separation

	Sample site		Laboratory		
	As(III), µg/l.	As(V), µg/l.	As(III), µg/l.	As(V), µg/l.	Total, µg/l.
Rockford Tunnel	3	<1	3	<1	3
Virginia Canyon Mine	2	1	2	1	3
Idaho Spring Mine	14	<1	15	<1	13
Lucania Mine	1	<1	<1	<1	1

The unused sample was brought back to the laboratory for further study by the same procedure.

Arsenic was determined in each portion of sample by graphite-furnace atomic-absorption spectrophotometry. An equal volume of 200-mg/l. nickel solution was added to the volume of sample in the graphite furnace (generally, 25 µl). The instrumental parameters are shown in Table 1. A calibration graph was constructed by analysing standards in the same way. Total arsenic for each sample was determined directly in the same manner, with an appropriate aliquot of the original sample.

RESULTS

Two ground-water samples and two laboratory standards with measurable concentrations of both As(III) and As(V) were introduced into the columns described. The effluent was collected in twenty successive 1-ml portions, each of which was analysed for arsenic. Plots of absorption signals (peak-heights) *vs.* eluate volume showed a definite chromatographic separation of two arsenic species (Fig. 1). All of the As(III) is eluted in the first 10 ml of effluent, there being little or no retention of As(III) by the acetate form of the resin. As the eluent (hydrochloric acid) passes through the column, the resin is converted from the acetate form into the chloride form, which has little or no affinity for As(V) in the acidic medium, and the arsenic(V) is eluted in the 13th and 14th 1-ml fractions. The change from acetate form to chloride form is evidenced by an accompanying slight colour change proceeding down the column. As(III) and As(V) in 13 ground-water samples from Utah and 5 acid mine waters from Colorado, that had been filtered and acidified at the sample site, were separated in the laboratory. The results are shown in Table 2.

Recovery studies involved adding As(III) and As(V) (each at the 5-µg/l. level) to each of six samples. The results in Table 3 for the spiked and original samples show that the recoveries of As(III) and As(V) ranged from 80 to 120% respectively, which is satisfactory at this level. That all of the arsenic is recovered can also be seen from the data in Table 2.

Table 5. Mean and standard deviation (S) for six separations of two samples

M002		BV012	
As(III), µg/l.	As(V), µg/l.	As(III), µg/l.	As(V), µg/l.
24	7	10	6
24	6	8	7
22	8	8	7
23	8	9	7
25	6	9	6
21	7	8	6
Mean = 23.3	7.0	8.7	6.5
S = 1.4	0.9	0.8	0.6

Separations of the arsenic species in some acid mine waters collected in the front range area of Colorado were done at the sample site and later in the laboratory. The values shown in Table 4 show satisfactory agreement between the two sets of results.

Two samples (M-002 and BV-012) were analysed six times each. The values, means and standard deviations are listed in Table 5.

A separation in the field takes about 15 min. In the laboratory, several columns can be used simultaneously for analysis of a number of samples. The columns are inexpensive and can be used several times before the resin must be replaced.

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BOD
(Biochemical Oxygen Demand)

Method 405.1

Optimum Concentration Range: 10-300 mg/l
Sensitivity: 4 mg/l
Approximate Detection Limit: 10 mg/l
LIMS Test Code: BOD5
Holding Time: 2 Days to Begin Incubation

1.0 Method Summary:

The sample of waste, or an appropriate dilution, is incubated for 5 days at 20¦C in the dark. The reduction in dissolved oxygen concentration during the incubation period yields a measure of the biochemical oxygen demand.

2.0 Bench Sheets:

Fill out the BOD bench sheet before beginning any analyses. Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. As the analysis proceeds, problems, variations, and other information are written on the bench sheet immediately. The analyst must initial and date the bench sheet when the sample run is set up and when the run is completed.

3.0 Spreadsheet:

All sample data and QC data should be entered into the BOD computer spreadsheet program within 24 hours after the analysis is completed. Calculations can be done manually or by use of the computer program. Date and initial the bench sheet when the data is entered into the spreadsheet program. When all QC data have been entered, all calculations have been made, and the spreadsheet information has been saved to disk, the analyst will print hard copies of the related control charts, and other pertinent areas of the spreadsheet. These hard copies will be initialled, and clipped to the original bench sheet. When bench sheets are completed, the analyst will make copies for each client/sample group represented in the analytical run. The original bench sheet is put into the parameter binder with other pertinent information, for data review and for data entry. Copies are filed with client- or sample-specific files, to facilitate the final review of the final report for a client or sample group.

The analyst then reviews the data according to section 6 in the SOP manual. This review should be done within 24 hours of the analysis. When the analyst has completed the review, the data packet is placed in the parameter binder in the laboratory with the time noted on the bench sheet.

4.0 Data Review Process:

After the data review process has been completed (see Section 6 of the SOP Manual), within 24 hours, it is the responsibility of the analyst to enter the data into LIMS or to have the data-entry clerk enter the data into LIMS. The person who enters the data will initial and date the bench sheet, with a time, and the binder will be returned to the laboratory.

5.0 Quality Control Samples:

For BOD analyses, the following control samples are included on the bench sheet and should be run with each batch of samples:

* method blank (dilution water blank)
* QC check sample
* duplicate samples

Acceptance limits for these quality control samples are as follows:

* method blank (dilution water blank) - An unseeded dilution water blank should be used as a rough check on the quality of this water and the cleanliness of the incubation bottles. The DO uptake should not exceed 0.2 mg/l.

* QC check sample - The spreadsheet has an area for entering data from the QC check sample. True value is given and the % recovery is calculated. This is charted on a control chart and statistical information is generated. The recovery on the QC sample must be within ± 3S for acceptance. When the QC recovery is outside this range, the system must be checked, a new QC sample made up, and the associated batch of samples must be re-analyzed. This must be documented on a corrective action report.

* duplicate samples - Generally an RPD of 20 is considered the outside limit. The spreadsheet has an area for entry of duplicate analysis data. This will be charted after each analytical run. Acceptance limits are RPD inside + 3S.

6.0 Calibration of DO meter:

6.1. Calibration against the Winkler method must be performed daily, and must be done prior to each set of DO measurements; results of calibration must be logged into the DO calibration log maintained close to the instrument.

6.1.1 Calibration is done on the dilution water. Initial calibration range should be between 7 mg/L and 9 mg/L. If the value is too low, dilution water should be aerated; if too high, a new water source should be obtained.

6.1.2 Taking meter reading:

a. Fill 2 BOD bottles with dilution water. Be careful not to agitate or aerate the water as the bottles are filled. Fill from the bottom to the top using a glass tube or rod.

b. Cap both bottles immediately.

c. Insert probe into Bottle 1; turn agitator to ON; allow to agitate for 3 minutes.

d. Read meter in mg/L. Record reading in DO logbook.

e. On Bottle 2, perform the modified Winkler. See Attachment A for this procedure.

f. With probe in Bottle 1, adjust the meter reading to agree with the results in mg/L O_2 obtained from the Winkler procedure.

g. Do not turn off the DO meter between the calibration and other readings to be made on the same day.

6.2. Reagents:

a) manganous sulfate solution: Dissolve 480 g manganous sulfate ($MnSO_4 \cdot 4H_2O$) in distilled water and dilute to 1 L.

b) Alkaline iodide-azide solution: Dissolve 500 g of NaOH, or 700 g of KOH and 135 g NaI, or 150 g of KI in distilled water and dilute to 1 L. To this solution, add 10 g of NaN_3 (sodium azide) dissolved in 40 mL distilled water.

c) concentrated sulfuric acid

d) starch solution: available commercially.

e) potassium fluoride solution: Dissolve 40 g $KF \cdot 2H_2O$ in distilled water and dilute to 100 mL.

f) sodium thiosulfate, stock solution, 0.75 N: Dissolve 186.15 g $Na_2S_2O_3 \cdot 5H_2O$ in boiled and cooled distilled wate and dilute to 1 L. Preserve by adding 5 mL chloroform.

g) sodium thiosulfate standard titrant, 0.0375N: Prepare by diluting 50.0 mL of stock solution to 1 L. Preserve by adding 5 mL chloroform. Standard sodium thiosulfate, exactly 0.0375N is equivalent to 0.300 mg of DO per 1.00 mL. Standardize with 0.0375 N potassium biiodate.

h) potassium biiodate, 0.0375 N: For stock solution dissolve 4.873 g of potassium biiodate, previously dried 2 hours at 103°C in 1000 mL distilled water. To prepare working standard, dilute 250 mL to 1000 mL for 0.0375 N.

6.3 Standardization of sodium thiosulfate:

6.3.1 Dissolve approximately 2 g KI in 100 to 150 mL distilled water; add 10 mL of 10% H_2SO_4 followed by 20 mL standard potassium biiodate. Place in dark for 5 minutes, dilute to 300 mL, and titrate with the standard sodium thiosulfate to a pale straw color. Add 1-2 mL starch solution and continue the titration drop by drop until the blue color disappears.

6.3.2 Run in duplicate. Duplicate determinations should agree within 0.05 mL.

6.3.3 To the calibration sample, add 2 mL manganous sulfate, followed by 2 mL of the alkaline iodide-azide solution, well below the surface of the liquid. Stopper with care to exclude air bubbles; mix well by inverting the bottle several times. When the precipitate settles, leaving a clear supernatant, shake again. When settling has produced at least 200 mL clear supernatant, carefully remove the stopper, and immediately add 2 mL concentrated H_2SO_4, allowing the acid to run down the neck of the bottle, re-stopper, and mix by gentle inversion until the iodine is uniformly distributed throughout the bottle. Complete the analysis within 45 minutes.

6.3.4 Transfer 203 mL of the contents to a wide-mouth flask. Titrate with 0.025 N sodium thiosulfate to a pale straw color. Add 1-2 mL of starch solution and continue to titrate to the first disappearance of the blue color.

6.3.5 Calculation:

a. Each ml of 0.025 N sodium thiosulfate is equivalent to 1 mg DO.

b. This procedure should be compared with the results using the DO meter. All results should be recorded in the DO calibration log kept close to the instrument.

7.0 BOD Analysis:

7.1 Apparatus:

a. incubation bottles: 250mL-300mL with ground-glass stoppers.

Clean bottles with detergent, rinse thoroughly and drain before use.

Use a water-seal. Invert bottles in a water bath or add water to the flared mouth of the BOD bottle. Place a paper or plastic cup over the flared mouth to reduce evaporation of the seal during incubation.

b. air incubator or water bath: thermostatically controlled at 20°± 1°C. All light must be excluded during incubation to prevent photosynthetic production of DO.

7.2 Reagents:

a. **phosphate buffer solution**

Dissolve 8.5 g KH_2PO_4, 21.75 g K_2HPO_4, 33.4 g $Na_2HPO_4 \cdot 7H_2O$, and 1.7 g NH_4Cl in about 500 mL distilled water and dilute to

1 L. Check the pH using a pH meter which has been properly calibrated. The pH should be 7.2 without further adjustment.

Discard any BOD reagent which shows any sign of biological growth in the stock bottle.

b. **magnesium sulfate solution**

Dissolve 22.5 g $MgSO_4 \cdot 7H_2O$ in distilled water and dilute to 1 L.

c. **calcium chloride solution**

Dissolve 27.5 g $CaCl_2$ in distilled water and dilute to 1 L.

d. **ferric chloride solution**

Dissolve 0.25 g $FeCl_3 \cdot 6H_2O$ in distilled water and dilute to 1 L.

e. **acid and alkali solutions, 1N**

H_2SO_4 - Add 28 mL concentrated sulfuric acid to about 500 mL distilled water. Dilute to 1 L and mix well.

NaOH - Add 40 g of NaOH to about 500 mL distilled water. Dilute to 1 L and mix well.

f. **sodium sulfite solution, 0.025N**

Dissolve 1.575 g Na_2SO_3 in 1 L distilled water. **This solution is not stable; prepare daily.**

g. **nitrification inhibitor:** Available commercially

h. **glucose-glutamic acid solution**

Dry reagent-grade glucose and reagent-grade glutamic acid at 103°C for 1 hour. Add 150 mg glucose and 150 mg glutamic acid to distilled water and dilute to 1 L. **Prepare fresh immediately before use.**

i. **sodium thiosulfate, 0.025 N:**

Dissolve 6.205 g $Na_2S_2O_3 \cdot 5H_2O$ in distilled water. Dilute to 1 L. Standardize.

7.3 **Procedure:**

7.3.1 Preparation of dilution water: Place desired volume of water in a suitable bottle and add 1 mL each of the phosphate buffer on day of analysis, $MgSO_4$, $CaCl_2$, and $FeCl_3$ solutions per liter of water. Seed dilution water, if desired. Test dilution water and store so that water of assured quality is always on hand.

7.3.2 Dilution water check: If dilution water has not been stored for quality improvement, add sufficient seeding material to produce a DO uptake of 0.05 to 0.1 mg/L in 5 d at 20°C. Do not seed dilution water that has been stored for quality improvement. Incubate a BOD bottle full of dilution water for 5 d at 20°C. Determine initial and final DO. The DO uptake in 5 days should not be more than 0.2 mg/L, and preferably not more than 0.1 mg/L.

Before use, bring dilution water temperature to 20°C. Saturate with DO by shaking in a partially filled bottle or by aerating with filtered air. Protect water quality by using clean glassware, tubing, and bottles.

7.3.3 Glucose-glutamic acid check: THIS CHECK MUST BE DONE AT LEAST ONCE A WEEK. IF THERE IS NO EPA QC CHECK SAMPLE AVAILABLE, THE SUGAR SAMPLE MUST BE RUN WITH EVERY BATCH OF BODs.

Use a mixture of 150 mg glucose/L and 150 mg glutamic acid/L as a standard "check" solution. Determine the 5-day 20°C BOD of a 2% dilution of the glucose-glutamic acid standard check solution.

If the BOD value is outside the range of 200 ± 37 mg/L, reject any BOD determinations made with the seed and dilution water and seek the cause of the problem.

7.3.4 Seeding: Some samples do not contain a sufficient microbial population. For such wastes, seed the dilution water by adding a population of microorganisms. The preferred seed is effluent from a biological treatment system processing the waste.

Determine BOD of the seeding material as for any other sample. This is the seed control. From the value of the seed control and a knowledge of the seeding material dilution determine seed DO uptake. To determine a sample DO uptake, subtract the seed DO uptake from the total DO uptake. The DO uptake of the seeded dilution water should be between 0.6 and 1.0 mg/L.

7.3.5 Sample pretreatment:

a. Samples containing caustic alkalinity or acidity: neutralize samples to pH 6.5 to 7.5 with H_2SO_4 or NaOH. The sample should not be diluted by more that 0.5%. The pH of seeded dilution water should not be affected by the lowest sample dilution.

b. Samples containing residual chlorine: If residual chlorine is present, dechlorinate and seed the dilution water. Destroy chlorine by adding Na_2SO_3 solution.

   1) Determine required volume of Na_2SO_3 on a 100-mL to 1000-mL portion of neutralized sample, by adding 10 mL of 1+1 acetic acid, 10 mL potassium iodide solution (10g/100mL), and titrating with 0.025N Na_2SO_3 to the starch-iodine endpoint.

   2) Add to the neutralized sample the volume of Na_2SO_3 solution determined by the above test, mix, and after 10 to 20 minutes, check sample for residual chlorine.

c. Samples supersaturated with DO: Samples containing more than 9 mg/L DO at 20°C may be brought to saturation by bringing sample to about 20°C in a partially filled bottle while shaking or aerating with compressed air.

d. Nitrification inhibition: If the 5-day CBOD is requested, add 3.33 mg 2-chloro-6 (trichloro methyl) pyridine to each bottle before capping or add sufficient amounts to the dilution water to make a final concentration of 10mg/L. Note the use of nitrogen inhibition in reporting results as Carbonaceous BOD.

7.3.6 Dilution technique: Make several dilutions of prepared sample to obtain a DO uptake in the range of 2 mg/L after 5 d incubation. In the absence of prior knowledge, use:

0.0 - 1.0% for strong industrial wastes
1.0 - 5.0 % for raw and settled wastewater
5.0 - 25.0% for biologically treated effluent
25.0 - 100% for polluted river waters

Prepare dilutions in volumetric flasks or directly in BOD bottles. Record dilution factors directly onto bench sheets as samples are diluted and prepared. A minimum of 3 dilutions are set up for each sample.

7.3.7 Determination of initial DO: If the sample contains materials that react rapidly with DO, determine initial DO immediately after filling BOD bottle. If rapid initial DO uptake is insignificant, the time period between preparing dilution and measuring initial DO is not critical.

7.3.8 Dilution water blank: Use a dilution water blank as a rough check on the quality of dilution water and BOD bottle cleanliness. With each batch of samples, incubate a bottle of unseeded dilution water. Determine initial and final DO uptake. The

DO uptake should not be more than 0.2 mg/L and preferably not more than 0.1 mg/L. If greater than 0.2 mg/l, the cause will be investigated and annotation made on the case narratives for affected samples.

7.3.9 Seed blank: With each batch of samples, incubate a bottle of seeded dilution water. Determine initial and final DO uptake.

7.3.10 Filled BOD sample bottles are covered with inverted paper cups to reduce evaporation, and placed in the BOD incubator at 20°C for 5 days. Final BOD values are determined at the end of the incubation period.

7.3.11 Using the DO probe to determine DO values:

a. The DO meter is usually left on. After the meter has been calibrated, the samples can be read. Switch is set to DO MEASURED.

b. Probe is placed into a beaker of distilled water and rinsed well. This is repeated after each sample reading.

c. Probe is placed into a BOD sample bottle and the stirrer turned on. The meter is allowed to stablize for a minimum of 3 minutes. Reading is recorded on bench sheet.

7.4 Calculation:

The bench sheets used (see example on following page) make the calculation of the DO very simple. Each column is used to record a specific value:

Column 0 = mls. of sample into BOD bottle
1 = dilution factor: 300ml divided by the mls of sample used = DF
2 = BOD bottle number
3 = initial DO uptake reading
4 = final DO uptake reading

5 = DO depletion (found by subtracting the value in column 4 from the value in column 3)
6 = % depletion (found by taking the depletion from column 5 and dividing it by the initial DO uptake from column 3. This is then multiplied by 100)
7 = BOD value (found by multiplying the DO depletion from column 5 by the dilution factor in column 1)

8.0 Reporting:

a. BODs are reported in mg/L O_2 of original sample.

b. Values below 2 mg/L are reported as < 2 mg/L O_2.

METHOD 9081

CATION-EXCHANGE CAPACITY OF SOILS (SODIUM ACETATE)

1.0 SCOPE AND APPLICATION

1.1 Method 9081 is applicable to most soils, including calcareous and noncalcareous soils. The method of cation-exchange capacity by summation (Chapman, 1965, p. 900; see Paragraph 10.1) should be employed for distinctly acid soils.

2.0 SUMMARY OF METHOD

2.1 The soil sample is mixed with an excess of sodium acetate solution, resulting in an exchange of the added sodium cations for the matrix cations. Subsequently, the sample is washed with isopropyl alcohol. An ammonium acetate solution is then added, which replaces the adsorbed sodium with ammonium. The concentration of displaced sodium is then determined by atomic absorption, emission spectroscopy, or an equivalent means.

3.0 INTERFERENCES

3.1 Interferences can occur during analysis of the extract for sodium content. Thoroughly investigate the chosen analytical method for potential interferences.

4.0 APPARATUS AND MATERIALS

4.1 Centrifuge tube and stopper: 50-mL, round-bottom, narrow neck.

4.2 Mechanical shaker.

4.3 Volumetric flask: 100-mL.

5.0 REAGENTS

5.1 Sodium acetate (NaOAc), 1.0 N: Dissolve 136 g of $NaC_2H_3O_2 \cdot 3H_2O$ in water and dilute it to 1,000 mL. The pH of this solution should be 8.2. If needed, add a few drops of acetic acid or NaOH solution to bring the reaction of the solution to pH 8.2.

5.2 Ammonium acetate (NH_4OAc), 1 N: Dilute 114 mL of glacial acetic acid (99.5%) with water to a volume of approximately 1 liter. Then add 138 mL of concentrated ammonium hydroxide (NH_4OH) and add water to obtain a volume of about 1,980 mL. Check the pH of the resulting solution, add more NH_4OH, as needed, to obtain a pH of 7, and dilute the solution to a volume of 2 liters with water.

5.3 Isopropyl alcohol: 99%.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 All samples must be collected using a sampling plan that addresses the considerations discussed in Chapter Nine of this manual.

7.0 PROCEDURE

7.1 Weigh 4 g of medium- or fine-textured soil or 6 g of coarse-textured soil and transfer the sample to a 50-mL, round-bottom, narrow-neck centrifuge tube. (A fine soil has >50% of the particles <0.074 mm, medium soil has >50% >0.425 mm, while a coarse soil has more than 50% of its particles >2 mm.

7.2 Add 33 mL of 1.0 N NaOAc solution, stopper the tube, shake it in a mechanical shaker for 5 min, and centrifuge it until the supernatant liquid is clear.

7.3 Decant the liquid, and repeat Paragraph 7.2 three more times.

7.4 Add 33 mL of 99% isopropyl alcohol, stopper the tube, shake it in a mechanical shaker for 5 min, and centrifuge it until the supernatant liquid is clear.

7.5 Repeat the procedure described in Paragraph 7.4 two more times.

7.6 Add 33 mL of NH_4OAc solution, stopper the tube, shake it in a mechanical shaker for 5 min, and centrifuge it until the supernatant liquid is clear. Decant the washing into a 100-mL volumetric flask.

7.7 Repeat the procedure described in Paragraph 7.6 two more times.

7.8 Dilute the combined washing to the 100-mL mark with ammonium acetate solution and determine the sodium concentration by atomic absorption, emission spectroscopy, or an equivalent method.

8.0 QUALITY CONTROL

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 Employ a minimum of one blank per sample batch to determine if contamination or any memory effects are occurring.

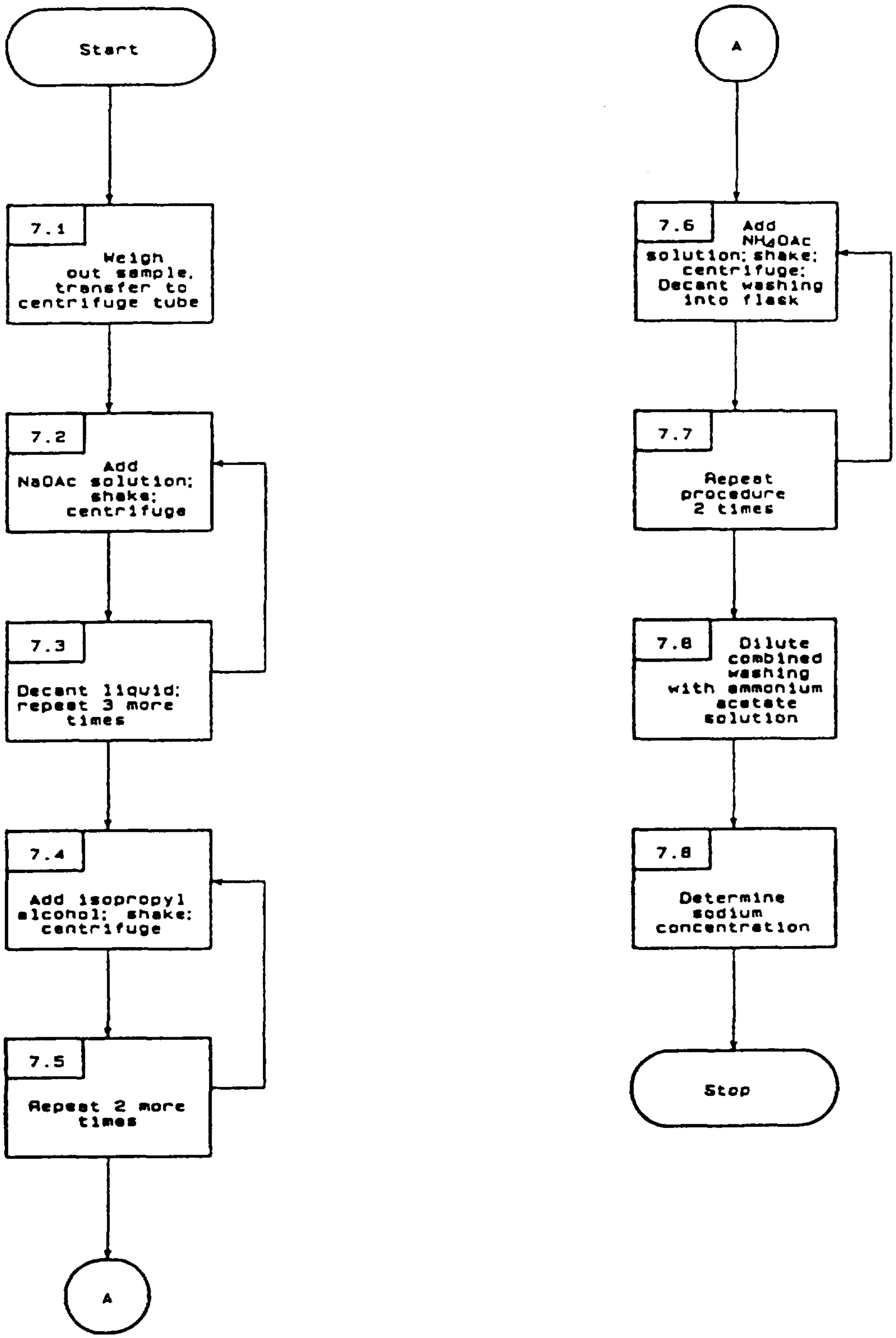
8.3 Materials of known cation-exchange capacity must be routinely analyzed.

9.0 METHOD PERFORMANCE

9.1 No data provided.

10.0 REFERENCES

10.1 This method is based on Chapman, H.D., "Cation-exchange Capacity," pp. 891-900, in C.A. Black (ed.), Method of Soil Analysis, Part 2: Chemical and Microbiological Properties, Am. Soc. Agron., Madison, Wisconsin (1965).


Start
7.1
Weigh out sample, transfer to centrifuge tube
7.2
Add NaOAc solution; shake; centrifuge
7.3
Decant liquid; repeat 3 more times
7.4
Add isopropyl alcohol; shake; centrifuge
7.5
Repeat 2 more times
A
A
7.6
Add NH_4OAc solution; shake; centrifuge; Decant washing into flask
7.7
Repeat procedure 2 times
7.8
Dilute combined washing with ammonium acetate solution
7.8
Determine sodium concentration
Stop

CHLORIDE

Method 407 B (Titration, Mercuric Nitrate)

Optimum Concentration Range:
Sensitivity:
Approximate Detection Limit:
LIMS Test Code: CL-
Holding Time: 28 Days

1.0 Method Summary:

An acidified sample is titrated with mercuric nitrate in the presence of mixed diphenylcarbazone-bromophenol blue indicator. The end point of the titration is the formation of the blue-violet mercury diphenylcarbazone complex.

2.0 Bench Sheets:

Fill out the CHLORIDE bench sheet before beginning any analyses. Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. As the analysis proceeds, problems, titration values, and other information are written on the bench sheet immediately. The analyst must initial and date the bench sheet when the sample run is completed.

3.0 Spreadsheets:

All sample data and QC data should be entered into the CHLORIDE computer spreadsheet program within 24 hours after the analysis is completed. All calculations, whether manual or by computer, must be completed within 24 hours after analysis is completed as well. Date and initial the bench sheet when the data is entered into the spreadsheet program. Results will be copied onto the bench sheets where appropriate, to facilitate entry of data into LIMS. When bench sheets are completed, a copy is made for each sample group or client represented in the analytical run. Client/sample names are highlighted. The original bench sheet is placed into the parameter binder with other information. Copies for each client are included with the client- or sample-specific file, to facilitate the final review of a specific client's samples before the report is issued to the client.

When all sample and QC data have been entered, all calculations have been made, and the spreadsheet information has been saved to disk, the analyst will print hard copies of the related analytical data, control charts, and other pertinent areas of the spreadsheet. These hard copies will be intitalled, and clipped to the original bench sheet. The analyst will review the data according to Section 6 in the SOP manual. This review should be done within 24 hours of the analysis. When the analyst has completed the review, the data packet is placed into the parameter binder in the laboratory with the time noted on the bench sheet.

4.0 Data Review Process:

After the data review process has been completed (see Section 6 of the SOP manual), within 24 hours it is the responsibility of the analyst to enter the data into LIMS or to have a data-entry clerk enter the data into LIMS. The person who enters the data will initial and date the bench sheet with a time, and the binder will be returned to the laboratory.

5.0 Quality Control Samples:

For CHLORIDE analyses, the following control samples are included on the bench sheet and should be run with each batch of samples:

* method blank
* QC check sample or method blank spike
* duplicate samples
* matrix spike/matrix spike duplicate (if required by a specific contract)

Acceptance limits for these quality control samples are as follows:

* method blank - if the analyte of interest is detected in the method blank, any sample in which the analyte is present at < 10X the level detected in the blank must be re-analyzed. The

spreadsheet has a section for entering blank result data.

* QC check sample - The spreadsheet has an area for entering data from the QC check sample. True value is given and the % recovery is calculated. This is charted on a control chart and statistical information is generated. The recovery on the QC sample must be within $\pm 3S$ for acceptance. When the QC recovery is outside this range, the system must be checked, a new QC sample made up, and the associated batch of samples must be re-analyzed.

* duplicate samples - Generally an RPD of 20 is considered the outside limit. The spreadsheet has an area for entry of duplicate analysis data. This will be charted after each analytical run. Acceptance limits are RPD inside +3S.

6.0 Analytical Procedure:

6.1 Apparatus:

a. Erlenmeyer flask, 250-ml

b. Microburet, 5-ml with 0.01-mL graduations

6.2 Reagents:

a. **Standard sodium chloride, 0.0141N**

Dissolve 824.0 mg NaCl (dried at 140°C) in distilled water and dilute to 1000 mL. (1.00 ml = 500 ug Cl-)

b. **Nitric acid, HNO_3, 0.1 N**

Add 6.4 mL of conc. HNO_3 to 900 mL distilled water in a 1000-mL volumetric flask. Mix thoroughly. Add water to volume.

c. **Sodium hydroxide, NaOH, 0.1 N**

Add 4.0 g of NaOH to 900 mL distilled water in a 1000-mL volumetric flask. Mix thoroughly. Add water to volume.

d. **Reagents for chloride concentrations <100 mg/L**

1) **Indicator-acidifier reagent**

a) Dissolve, in the order named,
250 mg s-diphenylcarbazone,
4.0 ml conc. HNO_3, and
30 mg xylene cyanol FF
in 100 mL 95% ethyl alcohol or isopropyl alcohol. Store in a dark bottle in a refrigerator.

b) pH control is critical.
Adjust pH of highly acid or alkaline samples to 2.5 0.1 with 0.1N HNO_3 or NaOH, **not with sodium carbonate.**

2) **Standard mercuric nitrate titrant**

a) Available commercially.
(1 mL = 5 mg Cl^-)

Store away from light in a dark bottle.

b) Standardization:

Use a 100-mL or smaller portion. Add 1.0 mL indicator-acidifier reagent. Titrate with 0.0141N $Hg(NO_3)_2$ titrant to a definite purple endpoint.

e. **Reagents for chloride concentrations >100 mg/L**

1) **Mixed indicator reagent**

Dissolve 0.50 g diphenylcarbazone

powder and 0.05 g bromphenol blue powder in 75 mL 95% ethyl or isopropyl alcohol and dilute to 100 mL with the same alcohol.

2) Strong standard mercuric nitrate titrant

Dilute from commercial stock. (1.00 mL = 5.00 mg Cl^-)

6.3 Procedure:

a. Titration of chloride concentrations less than 100 mg/L: Use a 100-mL sample or smaller portion so that the chloride content is less than 10 mg.

1) Add 1.0 mL indicator-acidifier reagent. (The color of the solution should be green-blue at this point. A light green indicates pH <2; a pure blue indicates pH >3.8.) For most potable waters, the pH after this addition will be 2.4-2.6. For highly alkaline or acid waters, adjust pH to about 8 before adding indicator-acidifier reagent.

2) Titrate with 0.0141N $Hg(NO_3)_2$ titrant to a definite purple end point. The solution turns from green-blue to blue a few drops before the end point.

3) Determine the blank by titrating 100 mL distilled water containing 10 mg $NaHCO_3$.

b. Titration of chloride concentrations greater than 100 mg/L: Use a sample portion (5 to 50 mL) requiring less than 5 mL to reach the end point. Measure into a 150-mL beaker.

1) Add approximately 0.5 mL mixed indicator reagent and mix well. The color should be purple.

2) Add 0.1N HNO_3 dropwise until the color just turns yellow.

3) Titrate with 0.141N $Hg(NO_3)_2$ titrant to first permanent dark purple.

4) Titrate a distilled water blank using the same procedure.

6.4 **Calculation:**

1) $$\text{mg Cl/L} = \frac{(A - B) \times N \times 35\,450}{\text{mL sample}}$$

where:

A = mL titration for sample

B = mL titration for blank

N = normality of $Hg(NO_3)_2$

2) mg NaCl/L = (mg Cl/L) x 1.65

7.0 Reporting:

a. Chloride is reported in units of mg Cl/L.

b. Values lower than 5 mg/L are reported as <5mg/L.

8.0 Notes:

8.1. Increasing the strength of the titrant and modifying the indicator mixtures extend the range of measurable chloride concentrations.

8.2. Bromide and iodide are titrated with $Hg(NO_3)_2$ in the same manner as chloride. Chromate, ferric, and sulfite ions interfere when present in excess of 10 mg/L.

8.3. The indicator-acidifier reagent is not stable indefinitely. Deterioration causes a slow end point and high results. Reagent a) contains sufficient HNO_3 to neutralize a total alkalinity of 150 mg as $CaCO_3$/L to the proper pH in a 100-mL sample. The amount of HNO_3 can be adjusted to accomodate samples of alkalinity different from 150 mg/L.

CHEMICAL OXYGEN DEMAND

Method 410.4 (Colorimetric)

Linear Concentration Range: 20 - 900 mg/l
Approximate Detection Limit: 20 mg/l
LIMS Test Code: COD4
Holding Time: 28 days

1.0 Scope and Application

1.1 This method covers the determination of COD in surface waters, domestic and industrial wastes.

1.2 The applicable range is 20 to 900 mg/l.

2.0 Summary Method

2.1 Sample, blanks and standards in sealed tubes are heated in an over or block-digestor in the presence of dichromate at 150° C. After two hours, the tubes are removed from the over or digestor, cooled and measured spectrophotometrically at 600 nm.

3.0 Sample Handling and Preservation

3.1 Collect the samples in glass bottles if possible. Use of plastic containers is permissible if it is known that no oraganic contaminants are present in the containers.

3.2 Samples should be preserved with sulfuric acid to a pH < 2 and maintained at 4° C until analysis.

4.0 Interferences

4.1 Chlorides are quantitatively oxidized by dichromate and represent a positive interference. Mercuric sulfate is added to the digestion tubes to complex the chlorides.

5.0 Apparatus

5.1 Drying oven or block digesgor, 500° C

5.2 Corning culture tubes, 16 x 100 mm or 25 x 150 mm with Teflon lined screw cap

5.3 Spectrophotometer

5.4 Muffle furnace, 500° C

5.5 Commercially available twist micro EPA approved digestion tubes (available from BioScience Inc., 174-318 Standard COD Vials).

6.0 Reagents

6.1 Digestion solution: Add 10.2 $K_2Cr_2O_7$, 167 ml conc. H_2SO_4 and 33.3 g $HgSO_4$ to 500 ml of distilled water, cool and dilute to 1 liter.

6.2 Catalyst solution: Add 22 g AG_2SO_4 to a 4.09kg bottle of conc. H_2SO_4. Stir until dissolved.

6.3 Sampler wash solution: Add 500 ml of conc H_2SO_4 to 500 ml of distilled water.

6.4 Stock potassium acid phthalate: Dissolve 0.850 g in 800 ml of distilled water and dilute to 1 liter. 1 ml = 1 mg COD. Potassium acid phthalate must be crushed and dried for 72 hours at 120° C and desiccated before weighing.

6.4.1 Prepare a series of standard solutions that cover the expected sample concentrations by diluting appropriate volumes of the stock standard.

Standards

ml of Stock KHP/100 ml	Conc of mg/l COD
2	20
5	50
10	100
25	250
40	400
60	600
90	900

7.0 Procedure

7.1 Wash all culture tubes and screw caps with 20% H_2SO_4 before their first use to prevent contamination. Trace contamination may be removed from the tubes by igniting them in a muffle oven at 500° C for 1 hour.

7.2 Lab prepared Vials.

7.2.1 Add 2.5 ml of sample to the 16 x 100 mm tubes.

7.2.2 Add 1.5 ml of digestion solution (6.1) and mix.

7.2.3 Add 3.5 ml of catalyst solution (6.2) carefully down the side of the culture tubes.

7.2.4 Cap tightly and shake to mix layers

7.2.5 Process standards and blanks exactly as the samples.

7.2.6 Place in over or block digestor at 150° C for two hours.

7.2.7 Cool, and place standards in sampler in order of decreasing concentration. Completely filling sampler tray with unknown samples.

7.2.8 Measure color intensity on Spectrophotometer at 600 nm.

7.3 Commercially Available Micro Vials

7.3.1 Add 2.5 ml of sample to prepared vials.

7.3.2 Replace cap firmly and shake to mix layers.

7.3.3 Place in oven or block digestor at 150° C for two hours.

7.3.4 Cool

7.3.5 Place layer of digested sample or standards in a standard 10 mm Quarts cell*.

7.3.6 Measure color intensity on spectrophotometer at 600 nm.

* Care should be taken not to get the mercuric sulfate in the UV cell.

8.0 Bench Sheets: Fill out the COD bench sheet before beginning any analyses. Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. As the analysis proceeds, problems, variations, and other information are written on the bench sheet immediately. The analyst must initial and date the bench sheet when the sample run is set up and when the run is completed.

9.0 Spreadsheet: All sample data and QC data should be entered into the COD computer spreadsheet program within 24 hours after the analysis is completed. Calculations can be done manually or by use of the computer program. Date and initial the bench sheet when the data is entered into the spreadsheet program. When all QC data have been entered, all calculations have been made, and the spreadsheet information has been saved to disk, the analyst will print hard copies of the related control charts, and other pertinent areas of the spreadsheet. These hard copies will be initialled, and clipped to the original bench sheet. When bench sheets are completed, the analyst will make copies for each client/sample group represented in the analytical run. The original bench sheet is put into the parameter binder with other pertinent information, for data review and for data entry. Copies are filed with client-or sample-specific files, to facilitate the final review of the final report for a client or sample group.

The analyst then reviews the data according to section 6 in the SOP manual. This review should be done within 24 hours of the analysis. When the analyst has completed the review, the data package is placed in the parameter binder in the laboratory with the time noted on the bench sheet.

10.0 Data Review Process: After the data review process has been completed (see Section 6 of the SOP Manual), within 24 hours, it is the responsibility of the analyst to enter the data into LIMS or to have the data-entry clerk enter the data into LIMS. The person who enters the data will initial and date the bench sheet, with a time, and the binder will be returned to the laboratory.

11.0 Quality Control Samples: For COD analyses, the following control samples are included on the bench sheets and should be run with each batch of samples:

- method blank (water blank)
- QC check sample
- duplicate samples

Acceptance limits for these quality control samples are as follows:

- method blank (water blank) - must be digested and analyzed with each digestion batch and have a result of < 20 mg/l.
- QC check sample - The spreadsheet has an area for entering data from the QC check sample. True value is given and the $ recovery is calculated. This is charted on a control chart and statistical information is generated. The recovery on the QC sample must be within $\pm$ 3S for acceptance. When the QC recovery is outside this range, the system must be checked, a new QC sample made up, and the associated batch of samples must be re-analyzed. This must be documented on a corrective action report. QC sample must be digested and analyzed with each digestion batch. QC sample must be an independent check sample such as EPA Demand PE or a Demand PE from Analytical Products Group, Inc.
- Duplicate samples - Generally an RPD of 20 is considered the outside limit. The spreadsheet has an area for entry of

duplicate analysis data. This will be charted after each analytical run. Acceptance limits are RPD inside + 3S.

pH

Method 150.1 (Electrometric)

Optimum Concentration Range:
Sensitivity:
Approximate Detection Limit:
LIMS Test Code: PH
Holding Time: 0 (Must be run as soon as it reaches lab)

1.0 Method Summary:

The pH of a sample is determined electrometrically using either a glass electrode in combination with a reference potential or a combination electrode.

2.0 Bench Sheets:

Fill out the pH bench sheet before beginning any analyses. Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. As the analysis proceeds, problems, observed values, and other information are written on the bench sheet immediately. The analyst must initial and date the bench sheet when the sample run is completed.

3.0 Spreadsheet:

All sample data and QC data should be entered into the pH computer spreadsheet program within 24 hours after the analysis is completed. Date and initial the bench sheet when the data is entered into the spreadsheet program. When all QC data have been entered, all calculations have been made, and the spreadsheet information has been saved to disk, the analyst will print hard copies of the related control charts, and other pertinent areas of the spreadsheet. These hard copies will be initialled, and clipped to the original bench sheet.

When bench sheets are completed, the analyst will make copies for each client/sample group represented in the analytical run. The original bench sheet is put into the parameter binder with other pertinent information, for data review and for data entry. Copies are filed with client- or sample-specific files, to facilitate the final review of the final report for a client or sample group.

The analyst then reviews the data according to section 6 in the SOP manual. This review should be done within 24 hours of the analysis. When the analyst has completed the review, the data packet is placed in the parameter binder in the laboratory with the time noted on the bench sheet.

4.0 Data Review Process:

After the data review process has been completed (see Section 6 of the SOP Manual), within 24 hours, it is the responsibility of the analyst to enter the data into LIMS or to have the data-entry clerk enter the data into LIMS. The person who enters the data will initial and date the bench sheet, with a time, and the binder will be returned to the laboratory.

5.0 Quality Control Samples:

For pH analyses, the following control samples are included on the bench sheet and should be run with each batch of samples:

* QC check sample

Acceptance limits for these quality control samples are as follows:

* QC check sample - The spreadsheet has an area for entering data from the QC check sample. True value is given and the % recovery is calculated. This is charted on a control chart and statistical information is generated.

  The QC check sample can be either an EPA-prepared sample (WP or WS) or an independent commercial buffer of a pH different from those of the buffers used in calibrating and standardizing the pH meter.

6.0 **Analytical Procedure:**

6.1 **Apparatus:**

a. pH meter - laboratory or field model.

b. Glass electrode.

c. Reference electrode - calomel, silver-silver chloride, or other reference electrode of constant potential.

d. Magnetic stirrer and Teflon-coated stirring bar.

e. Thermometer or temperature sensor for automatic compensation.

6.2 **Reagents:**

a. Standard buffers are available commercially.

6.3 **Procedure:**

a. Allow sample to reach room temperature.

b. Standardize and calibrate the pH meter. Standardize with pH 7 buffer; adjust slope with pH 4 buffer. Then read pH 10 buffer. Record all readings in the pH calibration log.

c. Place the sample in a clean glass beaker of adequate size for the electrode and the stirring bar.

d. Check the temperature.

e. After rinsing and gently wiping the electrodes, immerse them into the sample beaker and stir at a constant rate.

f. Note the pH reading and the temperature.

7.0 **Reporting:**

7.1 Report pH in units to the nearest 0.1.

b. Report temperature to the nearest degree Centigrade.

8.0 Notes:

8.1 Samples should be analyzed as soon as possible, preferably in the field at the time of sampling.

8.2 Sample containers should be filled completely and kept sealed prior to analysis.

8.3 Coatings of oily material or particulate material can impair electrode response. Remove by gentle wiping or detergent washing.

8.4 Temperature error is sample dependent and cannot be controlled. It should therefore be noted by reporting both the pH and the temperature at the time of analysis.

8.5 Check to see that the electrode is clean, free of crystallized material, and completely filled with solution.

SULFATE

Method 375.4 (Turbidimetric)

Optimum Concentration Range:
Sensitivity:
Approximate Detection Limit:
LIMS Test Code: SO4
Holding Time: 28 Days

1.0 Method Summary:

Sulfate ion is converted to a barium sulfate suspension under controlled conditions. The resulting turbidity is determined by a spectrophotometer or filter photometer and compared to a curve prepared from standard sulfate solutions.

2.0 Bench Sheets:

Fill out the **SULFATE** bench sheet before beginning any analyses. Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. As the analysis proceeds, problems, instrument readings, variations, and other information are written on the bench sheet immediately. The analyst must initial and date the bench sheet when the sample run is set up and when the run is completed.

3.0 Spreadsheet:

All sample data and QC data should be entered into the SULFATE computer spreadsheet program within 24 hours after the analysis is completed. Calculations can be done manually or by use of the computer program. Date and initial the bench sheet when the data is entered into the spreadsheet program.

When all QC data have been entered, all calculations have been made, and the spreadsheet information has been saved to disk, the analyst will print hard copies of the related control charts, and other pertinent areas of the spreadsheet. These hard copies will be initialled, and clipped to the original bench sheet. When bench sheets are completed, the analyst will make copies for each client/sample group represented in the analytical run. The original bench sheet is put into the parameter binder with other pertinent information, for data review and for data entry. Copies are filed with client- or sample-specific files, to facilitate the final review of the final report for a client or sample group.

The analyst then reviews the data according to section 6 in the SOP manual. This review should be done within 24 hours of the analysis. When the analyst has completed the review, the data packet is placed in the parameter binder in the laboratory with the time noted on the bench sheet.

4.0 Data Review Process:

After the data review process has been completed (see Section 6 of the SOP Manual), within 24 hours, it is the responsibility of the analyst to enter the data into LIMS or to have the data-entry clerk enter the data into LIMS. The person who enters the data will initial and date the bench sheet, with a time, and the binder will be returned to the laboratory.

5.0 Quality Control Samples:

For SULFATE analyses, the following control samples are included on the bench sheet and should be run with each batch of samples:

* method blank
* QC check sample
* duplicate samples

Acceptance limits for these quality control samples are as follows:

* method blank - used to zero the instrument

* QC check sample - The spreadsheet has an area for entering data from the QC check sample. True value is given and the % recovery is calculated. This is charted on a control chart and statistical information is generated. The recovery on the QC sample must be within $\pm$ 3S for acceptance. When the QC recovery is

outside this range, the system must be checked, a new QC sample made up, and the associated batch of samples must be re-analyzed. This must be documented on a corrective action report.

* duplicate samples - Generally an RPD of 20 is considered the outside limit. The spreadsheet has an area for entry of duplicate analysis data. This will be charted after each analytical run. Acceptance limits are RPD inside + 3S.

6.0 Analytical Procedure:

6.1 Apparatus:

a. Magnetic stirrer, variable speed so it can be held constant just below splashing. Use identical size and shape stirring bars.

b. Stopwatch or accurate timer.

c. Measuring spoon, capacity 0.2 to 0.3 mL.

6.2 Reagents:

a. conditioning reagent: Place 30 mL concentrated HCl, 300 mL distilled water, 100 mL 95% ethanol or isopropanol and 75 g NaCl in solution in a container. Add 50 mL glycerol and mix.

b. barium chloride, $BaCl_2$, crystals, 20 to 30 mesh

c. sodium carbonate solution, approximately 0.05 N: Dry 3 to 5 g primary standard Na_2CO_3 at 250°C for 4 hours and cool in a desiccator. Weigh 2.5 g (to the nearest mg), transfer to a 1 L volumetric flask, and fill to the mark with distilled water.

d. std sulfate solution (1.00 mL = 100 ug SO4): Dissolve 147.9 mg anhydrous Na_2SO_4 in distilled water. Dilute to 1 L.

6.3 Procedure:

6.3.1 Formation of barium sulfate turbidity:

1) Read all samples prior to addition of barium chloride, in order to correct for sample turbidity.

2) Place 100 mL sample or a suitable portion diluted to 100 mL into a 250-mL erlenmeyer flask.

3) Add exactly 5.0 mL conditioning reagent.

4) Mix in the stirring apparatus.

5) While the mixture is being stirred, add a measuring spoonful of $BaCl_2$ crystals and begin timing immediately.

5) Stir exactly 1.0 minutes at constant speed.

6.3.2 Measurement of barium sulfate turbidity:

1) Immediately after the stirring period has ended, pour the solution into an absorbance cell.

2) Let stand for exactly 5 minutes.

3) Record the reading.

6.3.3 Preparation of calibration curve:

1) Prepare calibration curve using standard sulfate solution.

2) Dilute standards as follows:

mL stock/100 mL	final conc. std
0 mL	0 mg/L
1 mL	1 mg/L
5 mL	5 mg/L
10 mL	10 mg/L
25 mL	25 mg/L
40 mL	40 mg/L

3) Check reliability of calibration curve by running a standard with every 3 to 4 samples.

6.3.4. Correction for sample color and turbidity:

Run each sample using the procedure, without the addition of barium chloride.

6.4 Calculation:

a. Read mg SO4 from calibration curve, using the PE spreadsheet program.

b. $\text{mg } SO_4/L = \frac{\text{mg } SO_4 \times 1000}{\text{mL sample}}$

7.0 Reporting:

a. Sulfate is reported in units of mg/L.

b. Samples with values lower than 1 mg/L are reported in LIMS as <1.

c. Samples with values higher than 40 mg/L must be diluted and re-analyzed.

8.0 Notes:

8.1 To obtain reliable readings, use a sample aliquot containing not more than 40 mg SO_4/L.

8.2 Suspended matter and color interfere. Correct by running blanks from which the barium chloride has been omitted.

8.3 Preserve by refrigeration at 4°C.

SULFIDE

Method 376.1 (Titrimetric, Iodine)

Optimum Concentration Range:
Sensitivity:
Approximate Detection Limit:
LIMS Test Code: S^-
Holding Time: 7 Days

1.0 Method Summary:

Excess iodine is added to a sample which may or may not have been treated with zinc acetate to produce zinc sulfide. The iodine oxidizes the sulfide to sulfur under acidic conditions. The excess iodine is backtitrated with sodium thiosulfate or phenylarsine oxide.

2.0 Bench Sheets:

Fill out the SULFIDE bench sheet before beginning any analyses. Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. As the analysis proceeds, problems, titration values, variations, and other information are written on the bench sheet immediately. The analyst must initial and date the bench sheet when the sample run is set up and when the run is completed.

3.0 Spreadsheet:

All sample data and QC data should be entered into the SULFIDE computer spreadsheet program within 24 hours after the analysis is completed. Calculations can be done manually or by use of the computer program. Date and initial the bench sheet when the data is entered into the spreadsheet program. When all QC data have been entered, all calculations have been made, and the spreadsheet information has been saved to disk, the analyst will print hard copies of the related control charts, and other pertinent areas of the spreadsheet. These hard copies will be initialled, and clipped to the original bench sheet.

When bench sheets are completed, the analyst will make copies for each client/sample group represented in the analytical run. The original bench sheet is put into the parameter binder with other pertinent information, for data review and for data entry. Copies are filed with client- or sample-specific files, to facilitate the final review of the final report for a client or sample group.

The analyst then reviews the data according to section 6 in the SOP manual. This review should be done within 24 hours of the analysis. When the analyst has completed the review, the data packet is placed in the parameter binder in the laboratory with the time noted on the bench sheet.

4.0 Data Review Process:

After the data review process has been completed (see Section 6 of the SOP Manual), within 24 hours, it is the responsibility of the analyst to enter the data into LIMS or to have the data-entry clerk enter the data into LIMS. The person who enters the data will initial and date the bench sheet, with a time, and the binder will be returned to the laboratory.

5.0 Quality Control Samples:

For SULFIDE analyses, the following control samples are included on the bench sheet and should be run with each batch of samples:

* method blank
* QC check sample

Acceptance limits for these quality control samples are as follows:

* method blank - if the analyte of interest is detected in the method blank, any sample in which the analyte is present at < 10X the level detected in the blank must be re-analyzed. The spreadsheet has a section for entering blank result data.

* QC check sample - The spreadsheet has an area for entering data from the QC check sample.

True value is given and the % recovery is calculated. This is charted on a control chart and statistical information is generated. The recovery on the QC sample must be within ± 3S for acceptance. When the QC recovery is outside this range, the system must be checked, a new QC sample made up, and the associated batch of samples must be re-analyzed. This must be documented on a corrective action report.

6.0 Analytical Procedure:

6.1 Apparatus:

a. ordinary laboratory glassware

6.2 Reagents:

a. Hydrochloric acid, HCl, 6 N: Place approximately 400 mL distilled water into a 1 L volumetric flask. Add 500 mL concentrated hydrochloric acid. Mix carefully. Bring to volume with distilled water.

b. Standard sodium thiosulfate, 0.1 N: Dissolve 25 g $Na_2S_2O_3 \cdot 5H_2O$ in 1 L freshly boiled distilled water.

c. Sodium thiosulfate titrant, 0.025 N: Dilute standard sodium thiosulfate by placing 25 mL in a 100 mL volumetric flask. Add freshly boiled water to volume.

d. Standard iodine solution, 0.0250 N:

1) Dissolve 20 to 25 g KI in a little water in a 1 L volumetric and add 3.2 g iodine. Allow to dissolve. Dilute to 1 L and standardize against 0.0250 N sodium thiosulfate or phenylarsine oxide using a starch indicator.

2) Standardization procedure: Titrate iodine solution with phenylarsine solution to a pale straw color. Add a small amount of indicator. After a

homogeneous blue color develops, continue to titrate drop by drop until the color disappears. Run in duplicate. Duplicate determinations should agree within 0.05 mL.

$$N(I_2) = \frac{\text{mL PAO} \times 0.0250}{20}$$

e. Phenylarsine oxide, 0.0250 N: commercially available.

f. Starch indicator: commercially available.

6.3 Procedure:

6.3.1 Unprecipitated sample:

1) Place a known amount of standard iodine solution into a 500 mL flask. The amount should be estimated to be in excess of the amount of sulfide expected.

2) Add 2 mL of 6 N HCl.

3) If the iodine color disappears, add more iodine until the color remains. Record the total number of mL of standard iodine used in performing these steps.

4) Titrate with the reducing solution (0.0250 N sodium thiosulfate or 0.0250 N phenylarsine oxide solution) using a starch indicator until the blue color disappears. Record the number of mL used.

6.3.2 Precipitated samples:

1) Add the reagents to the sample in the bottle.

2) Place a known amount of standard iodine solution in the bottle. The amount should be estimated to be in excess of the amount of sulfide expected.

3) Add 2 mL 6 N HCl.

4) If the iodine color disappears, add more iodine until color remains. Record the total number of mL of iodine solution used.

5) Titrate with reducing solution (sodium thiosulfate or PAO) using starch indicator until the blue color disappears. Record the number of mL used.

6.3.3 Dewatered samples:

1) Return the glass fiber filter paper which contains the sample to the original bottle. Add 200 mL distilled water. Proceed with steps as above.

2) The calculation should be based on the volume of the original sample put through the filter.

6.4 Calculation:

a. One mL of 0.0250 N standard iodine solution reacts with 0.4 mg sulfide present in the titration vessel.

b. Use the formula:

$$\text{mg/L sulfide} = \frac{400\ (A-B)}{\text{mL sample}}$$

where: A = mL of 0.0250 N iodine solution

B = mL 0.0250 N reducing solution

7.0 Reporting:

a. Sulfide is reported in units of mg/L.

b. Reporting limits: Values below the level of 0.5 mg/L are reported as <0.5.

8.0 Notes:

8.1 Acid insoluble sulfides are not measured by the use of this test.

8.2 Reduced sulfur compounds such as sulfite, thiosulfate, andhydrosulfite, which decompose in acid, may yield erratic results.

8.3 Volatile ioding-consuming substances will give high results.

8.4 Samples must be taken with a minimum of aeration. Sulfide may be volatilized by aeration and any oxygen inadvertently added to the sample may convert the sulfide to an unmeasurable form.

HARDNESS
(Total mg/L as $CaCO_3$)

Method 130.2 (Titrimetric, EDTA)

Optimum Concentration Range:
Sensitivity:
Approximate Detection Limit:
LIMS Test Code: **HARD**
Holding Time: **6 Months**

1.0 Method Summary:

Calcium and magnesium ions in the sample are sequestered upon the addition of disodium ethylenediamine tetraacetate (Na_2EDTA). The end point of the reaction is detected by means of Eriochrome Black T indicator, which has a red color in the presence of calcium and magnesium and a blue color when the cations are sequestered.

2.0 Bench Sheets:

Fill out the **HARDNESS** bench sheet before beginning any analyses. Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. As the analysis proceeds, problems, variations, titration values, and other information are written on the bench sheet immediately. The analyst must initial and date the bench sheet when the sample run is set up and when the run is completed.

3.0 Spreadsheet:

All sample data and QC data should be entered into the HARDNESS computer spreadsheet program within 24 hours after the analysis is completed. Calculations can be done manually or by use of the computer program. Date and initial the bench sheet when the data is entered into the spreadsheet program. When all QC data have been entered, all calculations have been made, and the spreadsheet information has been saved to disk, the analyst will print hard copies of the related control charts, and other pertinent areas of the spreadsheet. These hard copies will be initialled, and clipped to the original bench sheet.

When bench sheets are completed, the analyst will make copies for each client/sample group represented in the analytical run. The original bench sheet is put into the parameter binder with other pertinent information, for data review and for data entry. Copies are filed with client- or sample-specific files, to facilitate the final review of the final report for a client or sample group.

The analyst then reviews the data according to section 6 in the SOP manual. This review should be done within 24 hours of the analysis. When the analyst has completed the review, the data packet is placed in the parameter binder in the laboratory with the time noted on the bench sheet.

4.0 Data Review Process:

After the data review process has been completed (see Section 6 of the SOP Manual), within 24 hours, it is the responsibility of the analyst to enter the data into LIMS or to have the data-entry clerk enter the data into LIMS. The person who enters the data will initial and date the bench sheet, with a time, and the binder will be returned to the laboratory.

5.0 Quality Control Samples:

For HARDNESS analyses, the following control samples are included on the bench sheet and should be run with each batch of samples:

* method blank
* QC check sample
* duplicate samples

Acceptance limits for these quality control samples are as follows:

* method blank - if the analyte of interest is detected in the method blank, any sample in which the analyte is present at < 10X the level detected in the blank must be re-analyzed. The spreadsheet has a section for entering blank result data.

* QC check sample - The spreadsheet has an area for entering data from the QC check sample. True value is given and the % recovery is calculated. This is charted on a control chart and statistical information is generated. The recovery on the QC sample must be within ± 3S for acceptance. When the QC recovery is outside this range, the system must be checked, a new QC sample made up, and the associated batch of samples must be re-analyzed. This must be documented on a corrective action report.

* duplicate samples - Generally an RPD of 20 is considered the outside limit. The spreadsheet has an area for entry of duplicate analysis data. This will be charted after each analytical run. Acceptance limits are RPD inside + 3S.

6.0 Analytical Procedure:

6.1 Apparatus:

a. Standard laboratory titrimetric equipment.

6.2 Reagents:

a. Buffer solution

1) Dissolve 1.179 g disodium EDTA (analytical reagent grade) and 780 mg $MgSO_4 \cdot 7H_2O$ (or 644 mg $MgCl_2 \cdot 6H_2O$) in 50 mL distilled water. Add this solution to 250 mL volumetric flask containing 16.9 g NH_4Cl and 143 mL concentrated NH_4OH with mixing. Dilute to the mark with distilled water.

2) Store in a tightly stoppered plastic bottle; stable for approximately 1 month. Dispense with bulb operated pipet. Discard when 1-2 mL added to sample fails to produce a pH of 10.0 at the endpoint of titration.

3) Commercially available "odorless" buffers may also be used.

b. Indicator: Mix together 0.5 g Eriochrome Black T, and 4.5 g hydroxylamine HCl. Dilute to volume in a 100 mL volumetric flask with n-propyl alcohol.

c. Standard EDTA titrant, 0.02 N: Place 3.723 g analytical reagent grade disodium ethylenediamine tetraacetate dihydrate in a 1 L volumetric flask and dilute to the mark with distilled water. Check with standard calcium solution by titration. Store in polyethylene. Check monthly because of gradual deterioration.

1) Place 10.0 mL standard calcium solution in vessel containing about 50 mL distilled water. Add 1 mL buffer solution. Add 1-2 drops indicator or small scoop of dry indicator. Titrate slowly with continuous stirring until the last reddish tinge disappears; adding last few drops at 3-5 second intervals. At end point, the color is blue. Total titration should be 5 minutes from the time of buffer addition.

2) $$\text{N of EDTA} = \frac{0.2}{\text{mL of EDTA}}$$

d. Standard calcium solution, 0.02 N:

1) Place 1.000 g anhydrous calcium carbonate (primary grade low in metals) in a 500 mL flask.

2) Add, a little at a time, 1+1 HCl until all the $CaCO_3$ has been dissolved. Add 200 mL distilled water. Boil for a few minutes to expel CO_2.

3) Cool. Add a few drops of methyl red indicator and adjust to intermediate orange color by adding 3N NH_4OH or 1+1 HCl as required. Quantitatively transfer

to a 1 L volumetric flask and dilute to the mark with distilled water.

e. Hydrochloric acid solution, 1+1: Dilute 500 mL concentrated HCl to 1000 mL with distilled water.

f. Methyl red indicator: Dissolve 0.10 g methyl red in distilled water in a 100 mL volumetric. Dilute to the mark with distilled water.

g. Ammonium hydroxide solution, 3 N: Dilute 210 mL of concentrated NH_4OH to 1 L with distilled water.

h. Ammonium hydroxide solution, 1 N: Dilute 70 mL of concentrated NH_4OH to 1 L with distilled water.

6.3 **Procedure:**

6.3.1 Pre-treatment:

1) For drinking waters, surface waters, saline waters, and dilutions thereof, no pre-treatment steps are necessary.

2) For most wastewaters, and highly polluted waters, the sample must be digested as given in the Atomic Absorption Methods section of the EPA methods manual.

6.3.2 Titration of sample - normal to high hardness:

1) Sample should require <15 mL EDTA titrant and titration should be completed within 5 minutes of buffer addition.

2) Place 25 mL sample in titration vessel, neutralize with 1 N ammonium hydroxide and dilute to about 50 mL.

3) Add 1-2 mL buffer solution.

4) Add a small scoop of dried powder indicator formula.

5) Titrate slowly with continuous stirring with standard EDTA titrant until last reddish tint disappears. Solution is normally blue at end point.

6.3.3 Titration of sample - low hardness (< 5 mg/L)

1) Use a larger sample (100 mL)

2) Use proportionately larger amounts of buffer and indicator.

3) Use a microburet and run a blank using redistilled or deionized water.

6.4 Calculation:

$$\text{Hardness (EDTA)} = \frac{A \times N \times 50\,000}{\text{mL sample}}$$

where: A = mL EDTA titrant
N = normality of EDTA titrant

7.0 Reporting:

a. Hardness is reported in mg $CaCO_3$/L.

b. Values below 4 mg/L are reported as <4.

8.0 Notes:

8.1 The method is suitable for all concentration ranges of hardness; however, in order to avoid large titration volumes, use a sample aliquot containing not more than 25 mg $CaCO_3$.

8.2 Samples should be cooled to 4°C and preserved to pH <2 by addition of HNO_3.

TOTAL DISSOLVED SOLIDS
(Residue, Filterable)

Method 160.1 (Gravimetric, Dried at 180°C)

Optimum Concentration Range: 10 mg.L - 20 000 mg/L
Sensitivity:
Approximate Detection Limit: 10 mg/L
LIMS Test Code: TDS
Holding Time: 7 Days

1.0 Method Summary:

A well-mixed sample is filtered through a standard glass fiber filter. The filtrate is evaporated and dried to constant weight at 180°C.

If TSS (Residue, Non-Filterable) is being determined, the filtrate from that method may be used for TDS (Residue, Filterable).

2.0 Bench Sheets:

Fill out the TOTAL DISSOLVED SOLIDS bench sheet before beginning any analyses. Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. As the analysis proceeds, problems, weights, variations, and other information are written on the bench sheet immediately. The analyst must initial and date the bench sheet when the sample run is set up and when the run is completed.

3.0 Spreadsheet:

All sample data and QC data should be entered into the TOTAL DISSOLVED SOLIDS computer spreadsheet program within 24 hours after the analysis is completed. Calculations can be done manually or by use of the computer program. Date and initial the bench sheet when the data is entered into the spreadsheet program. When all QC data have been entered, all calculations have been made, and the spreadsheet information has been saved to disk, the analyst will print hard copies of the related control charts, and other pertinent areas of the spreadsheet. These hard copies will be initialled, and clipped to the original bench sheet. When bench sheets are completed, the analyst will make copies for each client/sample group represented in the analytical run. The original bench sheet is put into the parameter binder with other pertinent information, for data review and for data entry. Copies are filed with client- or sample-specific files, to facilitate the final review of the final report for a client or sample group.

The analyst then reviews the data according to section 6 in the SOP manual. This review should be done within 24 hours of the analysis. When the analyst has completed the review, the data packet is placed in the parameter binder in the laboratory with the time noted on the bench sheet.

4.0 Data Review Process:

After the data review process has been completed (see Section 6 of the SOP Manual), within 24 hours, it is the responsibility of the analyst to enter the data into LIMS or to have the data-entry clerk enter the data into LIMS. The person who enters the data will initial and date the bench sheet, with a time, and the binder will be returned to the laboratory.

5.0 Quality Control Samples:

For TOTAL DISSOLVED SOLIDS analyses, the following control samples are included on the bench sheet and should be run with each batch of samples:

* method blank
* QC check sample
* duplicate samples

Acceptance limits for these quality control samples are as follows:

* method blank - if the analyte of interest is detected in the method blank, any sample in which the analyte is present at < 10X the level detected in the blank must be re-analyzed. The spreadsheet has a section for entering blank result data.

* QC check sample - The spreadsheet has an area for entering data from the QC check sample. True value is given and the % recovery is calculated. This is charted on a control chart and statistical information is generated. The recovery on the QC sample must be within ± 3S for acceptance. When the QC recovery is outside this range, the system must be checked, a new QC sample made up, and the associated batch of samples must be re-analyzed. This must be documented on a corrective action report.

* duplicate samples - Generally an RPD of 20 is considered the outside limit. The spreadsheet has an area for entry of duplicate analysis data. This will be charted after each analytical run. Acceptance limits are RPD inside + 3S.

6.0 Analytical Procedure:

6.1 Apparatus:

a. Glass fiber filter disks, 9.0 cm, without organic binder, Whatman type 934-AH, Gelman type A/E, or equivalent.

b. Filter holder, membrane filter funnel, or Gooch crucible adapter.

c. Suction flask, 500 mL

d. Evaporating dishes, porcelain, 100 mL volume. (Vycor or platinum dishes may be substituted.)

e. Drying oven, 180°C.

f. Desiccator.

g. Analytical balance capable of weighing to 0.1 mg.

6.2 Procedure:

6.2.1 Preparation of glass filter disk:

1) Place the disk on the membrane filter apparatus or insert into bottom of a suitable Gooch crucible.

2) While a vacuum is applied, wash the disk with three successive 20 mL volumes of distilled water.

3) Remove all traces of water by continuing to apply vacuum after water has passed through. Discard all washings.

6.2.2 Preparation of evaporating dishes:

1) If volatile residue is also to be measured, heat the clean dish to 550°C for 1 hour in a muffle furnace. If only filterable residue is to be measured, heat the clean dish to 180°C for one hour.

2) Cool in desiccator and store until needed.

3) Weigh immediately before use.

6.2.3 Analytical procedure:

1) Assemble the filtering apparatus and begin suction.

2) Shake the sample vigorously and rapidly transfer 100 mL to the funnel by means of a 100 mL graduated cylinder. If total filterable residue is low, a larger volume may be filtered.

3) Filter the sample through the glass fiber filter, rinse with three 10 mL portions of distilled water and continue to apply vacuum for about 3 minutes after filtration is complete to remove as much water as possible.

4) Tranfer 100 mL or a larger volume of the filtrate to a weighed evaporating dish and evaporate to dryness on a steam bath.

5) Dry the evaporated sample for at least 1 hour at 180°C. Cool in a desiccator and weigh.

6) Repeat the drying cycle until a constant weight is obtained, or until weight loss is less than 0.5 mg.

6.3 **Calculation:**

Calculate filterable residue (TDS) as follows:

$$\text{TDS mg/L} = \frac{(A - B) \times 1000}{C}$$

where: A = weight of dried residue + dish in mg
B = weight of dish in mg
C = volume of sample used in mL

7.0 Reporting:

a. Total dissolved solids (filterable residue) is reported in units of mg/L.

b. Values below 10 mg/L are reported as <10.

8.0 Notes:

8.1 The practical range of determination is 10 mg/L to 20 000 mg/L.

8.2 Filterable residue is defined as those solids capable of passing through a glass fiber filter and dried to constant weight at 180°C.

8.3 Preservation of the sample is not practical; analysis should begin as soon as possible. Refrigeration or icing to 4°C to minimize microbiological decomposition of solids is recommended.

8.4 Highly mineralized waters containing significant concentrations of calcium, magnesium, chloride, and/or sulfate may be hygroscopic and will require prolonged drying, desiccation, and rapid weighing.

8.5 Samples containing high concentrations of bicarbonate will require careful and possibly prolonged drying at 180°C to insure that all the bicarbonate is converted to carbonate.

8.6 Too much residue in the evaporating dish will crust over and entrap water that will not be driven off during drying. Total residue should be limited to about 200 mg.

SOP No.: I-0002-LGN
Rev. No.: 0
Date issued:
Date initiated:
Written by: K. Starcher

TOTAL ORGANIC CARBON (TOC), WATER

Method 415.1

Optimum Concentration Range:
Sensitivity:
Reporting Detection Limit: 1.0 mg/l
Reporting Units: mg/l
Significant Figures: 3
Holding Time: 28 Days

1.0 Method Summary

1.1 The organic carbon in a sample is converted to carbon dioxide (CO_2) by wet chemical oxidation. The CO_2 formed is measured directly by an infrared detector.

1.2 The TOC analyzer used is a Dohrmann DC-80 Total Organic Carbon Analyzer with an ASM-1 Autosampler.

2.0 Bench Sheets

Benchsheets or laboratory notebooks are to be used to enter raw data. For this SOP the term benchsheet will be used to signify either a benchsheet or a notebook entry. Use a run log to reference autosampler positions and sample descriptions when setting up to run.

Include all pertinent information such as sample size, dilution factors, dates of analysis, and sample ID. When a run is finished, attach the instrument printout to the bench sheet. The analyst must initial and date the bench sheet when the sample run is completed.

3.0 Spreadsheet

All sample data and QC data should be entered into the CYANIDE computer spreadsheet within 24 hours after the analysis is completed. Calculations can be done either by using the calculation area of the computer spreadsheet, or manually. Enter all QC data in the appropriate areas of the spreadsheet. Date and initial the bench sheet when the data is entered into the spreadsheet program.

4.0 Data Review Process

Within 24 hours the data review process should be completed. It then becomes the responsibility of the analyst to enter the data onto the Work In Progress (WIP) sheets or LIMS System or to see that a data entry person does so. The person who enters the data will initial and date the bench sheet and file it.

5.0 Quality Control Samples

The following quality control samples are required for TOC analysis:

5.1 Calibration Standard: The calibration standard is diluted from a standard CN solution in the concentration appropriate for the range to be used. This standard is used to calibrate the instrument.

5.2 ICVS: One ICVS must be run before each run of samples. On the run log, the ICVS must be identified. The ICVS may also serve as the LCS. The acceptable recovery range for ICVS is 90.0-110.0%.

5.3 Method Blank (Preparation or Reagent Blank): One method blank must be analyzed per run. On the run log, the method blank must be identified

5.4 LCS: May be the ICVS.

5.5 CCVS: A mid-range standard run after every 10 samples. Use the same CCVS throughout the run. The acceptable recovery range is 90.0-110.0%. If a CCVS exceeds this range, stop analyses, determine the problem, recalibrate and verify the curve, and rerun all samples run since the last acceptable CCVS.

5.6 Matrix Spike (MS): 1 per 20 samples.

5.7 Duplicates or Matrix Spike Duplicates (MSD): 1 per 20 samples.

6.0 Sample Handling and Preservation

6.1 Samples are preserved with H_2SO_4 (or HCl).

6.4 Samples must be stored at 4°C (± 2°C) and must be analyzed within holding time of 28 days.

6.5 Interferences

6.5.1 Carbonate and bicarbonate carbon are positive interferences. Acidifying and sparging the samples with oxygen will eliminate the interference.

7.0 Apparatus

7.1 Dohrmann DC-80 Total Organic Carbon Analyzer with ASM-1 Autosampler.

8.0 Reagents

8.1 Deionized water, organic free.

8.2 Potassium persulfate solution: Dissolve 20 g reagent grade potassium persulfate ($K_2S_2O_8$) in 1 liter of reagent water. Add 1 ml concentrated phosphoric acid and mix. Store in a cool dark location. Shelf life is 1 month.

8.3 Organic carbon standards: Dry 3-5 g potassium hydrogen phthalate ($C_8H_5O_4K$, KHP) to a constant weight. Carefully weigh 2.125 g dried KHP, and dissolve in deionized water. Add 0.5 ml concentrated phosphoric acid and dilute to 500 ml in a volumetric flask. Store in dark glass, under refrigeration. Replace monthly.

8.3.1 400 ppm standard solution: Dilute 200 ml of 2000 ppm stock standard solution to 1000 ml. Store in dark glass, under refrigeration. Prepare fresh weekly.

8.3.2 For other standard concentrations, dilute the 2000 ppm stock solution appropriately.

9.0 Procedure:

9.1 Follow instrument manufacturer's instruction for calibration, procedure, and calculations.

9.2 After instrument is calibrated, set up run as follows:

1. ICVS
2. Method Blank
3. LCS
4. CCVS after every 10 samples
5. CCVS and method blank at end of run

9.3 If necessary to insure non-carryover between samples, run a blank between every sample.

4500-CN⁻ M. Thiocyanate

1. General Discussion

When wastewater containing thiocyanate (SCN^-) is chlorinated, highly toxic cyanogen chloride (CNCl) is formed. At an acidic pH, ferric ion (Fe^{3+}) and SCN^- form an intense red color suitable for colorimetric determination.

a. Interference:

1) Hexavalent chromium (Cr^{6+}) interferes and is removed by adding ferrous sulfate ($FeSO_4$) after adjusting to pH 1 to 2 with nitric acid (HNO_3). Raising the pH to 9 with 1*N* sodium hydroxide (NaOH) precipitates Fe^{3+} and Cr^{3+}, which are then filtered out.

2) Reducing agents that reduce Fe^{3+} to Fe^{2+}, thus preventing formation of ferric thiocyanate complex, are destroyed by adding a few drops of hydrogen peroxide (H_2O_2). Avoid excess H_2O_2 to prevent reaction with SCN^-.

3) Industrial wastes may be highly colored or contain various interfering organic compounds. To eliminate these interferences,[1] use the pretreatment procedure given in ¶ 4*c* below. It is the analyst's responsibility to validate the method's applicability without pretreatment (¶ 4*b*). If in doubt, pretreat sample before proceeding with analysis (¶ 4*c*).

4) If sample contains cyanide amenable to chlorination and would be preserved for the cyanide determination at a high pH, sulfide could interfere by converting cyanide to SCN^-. To preserve SCN^- and CN^-, precipitate the sulfide by adding lead salts according to 4500-CN⁻.B.2 before adding alkali; filter to remove precipitate.

5) Thiocyanate is biodegradable. Preserve samples at pH <2 by adding mineral acid and refrigerate.

6) If interferences from industrial wastes are not removed as directed in ¶ 4*c* below, consider adopting a solvent extraction technique with colorimetric or atomic absorption analysis of the extract.[2,3]

b. Application: 0.1 to 2.0 mg SCN^-/L in natural or wastewaters. For higher concentrations use a portion of diluted sample.

2. Apparatus

a. Spectrophotometer or filter photometer, for use at 460 nm, providing a light path of 5 cm.

b. Glass adsorption column: Use a 50-mL buret with a glass-wool plug, and pack with macroreticular resin (¶ 3*f*) approximately 40 cm high. For convenience, apply a powder funnel of the same diameter as the buret to the top with a short piece of plastic tubing.

3. Reagents

a. Ferric nitrate solution: Dissolve 404 g $Fe(NO_3)_3 \cdot 9H_2O$ in about 800 mL distilled water. Add 80 mL conc HNO_3 and dilute to 1 L.

b. Nitric acid solution, 0.1*N*: Mix 6.4 mL conc HNO_3 in about 800 mL distilled water and dilute to 1 L.

c. Stock thiocyanate solution: Dissolve 1.673 g potassium thiocyanate (KSCN) in distilled water and dilute to 1000 mL; 1.00 mL = 1.00 mg SCN^-.

d. Standard thiocyanate solution: Dilute 10 mL stock solution to 1 L with distilled water; 1.00 mL = 0.01 mg SCN^-.

e. Sodium hydroxide solution, 4 g/L: Dissolve 4 g NaOH in about 800 mL distilled water and dilute to 1 L.

f. Macroreticular resin, 18 to 50 mesh:* The available resin may not be purified. Some samples have shown contamination with waxes and oil, giving poor permeability and adsorption. Purify as follows:

Place sufficient resin to fill the column or columns in a beaker and add 5 times the resin volume of acetone. Stir gently for 1 h. Pour off fines and acetone from settled resin and add 5 times the resin volume of hexane. Stir for 1 h. Pour off fines and hexane and add 5 times the resin volume of methanol. Stir for 15 min. Pour off methanol and add 3 times the resin volume of 0.1*N* NaOH. Stir for 15 min. Pour off NaOH solution and add 3 times the resin volume of 0.1*N* HNO_3. Stir for 15 min. Pour off HNO_3 solution and add 3 times the resin volume of distilled water. Stir for 15 min. Drain excess water and use purified resin to fill the column. Store excess purified resin after covering it with distilled water. Keep in a closed jar.

g. Methyl alcohol.

4. Procedure

a. Preparation of calibration curve: Prepare a series of standards containing from 0.02 mg to 0.40 mg SCN^- by pipetting measured volumes of standard KSCN solution into 200-mL volumetric flasks and diluting with water. Mix well. Develop color according to ¶ *b* below. Plot absorbance against SCN^- concentration expressed as mg/50 mL sample. The absorbance plot should be linear.

b. Color development: Use a filtered sample or portion from a diluted solution so that the concentration of SCN^- is between 0.1 and 2 mg/L. Adjust pH to 2 with conc HNO_3 added dropwise. Pipet 50-mL portion to a beaker, add 2.5 mL ferric nitrate, and mix.

Fill a 5-cm absorption cell and measure absorbance against a reagent blank at 460 nm or close to the maximum absorbance found with the instrument being used. Measure absorbance of the developed color against a reagent blank within 5 min from adding the reagent. (The color develops within 30 s and fades on standing in light.)

c. Sample pretreatment:

1) Color and various organic compounds interfere with absorbance measurement. At pH 2, macroreticular resin removes these interfering materials by adsorption without affecting thiocyanate.

2) To prepare the adsorption column, fill it with resin, rinse with 100 mL methanol, and follow by rinses with 100 mL 0.1*N* NaOH, 100 mL 0.1*N* HNO_3, and finally with 100 mL distilled water. If previously purified resin is used, omit these preparatory steps.

3) When washing, regenerating, or passing a sample through the column, as solution level approaches resin bed, add and drain five separate 5-mL volumes of solution or water (depending on which is used in next step) to approximate bed height. After last

* Amberlite® XAD-8, Rohm & Haas Company, or equivalent.

5-mL volume, fill column with remaining liquid. This procedure prevents undue mixing of solutions and helps void the column of the previous solution.

4) Acidify 150 mL sample (or a dilution) to pH 2 by adding conc HNO_3 dropwise while stirring. Pass it through the column at a flow rate not to exceed 20 mL/min. If the resin becomes packed and the flow rate falls to 4 to 5 mL/min, use gentle pressure through a manually operated hand pump or squeeze bulb on the column. In this case, use a separator funnel for the liquid reservoir instead of the powder funnel. Alternatively use a vacuum bottle as a receiver and apply gentle vacuum. Do not let liquid level drop below the adsorbent in the column.

5) When passing a sample through the column, measure 90 mL of sample in a graduated cylinder, and from this use the five 5-mL additions as directed in ¶ 3), then pour the remainder of the 90 mL into the column. Add rest of sample and collect 60 mL eluate to be tested after the first 60 mL has passed through the column.

6) Prepare a new calibration curve using standards prepared according to ¶ 4*a*, but acidify standards according to ¶ 4*b*, and pass them through the adsorption column. Develop color and measure absorbance according to ¶ 4*b* against a reagent blank prepared by passing acidified, distilled water through the adsorption column.

7) Pipet 50 mL from the collected eluate to a beaker, add 2.5 mL ferric nitrate solution, and mix. Measure absorbance according to ¶ 4*b* against a reagent blank [see ¶ 6) above].

8) From the measured absorbance value, determine thiocyanate content of the sample or dilution using the absorbance plot.

9) Each day the column is in use, test a mid-range standard to check absorption curve.

10) Regenerate column between samples by rinsing with 100 mL 0.1*N* NaOH; 50 mL 0.1*N* HNO_3; and 100 mL water. Insure that the water has rinsed empty glass section of the buret. Occasionally rinse with 100 mL methanol for complete regeneration. Adsorbed weak organic acids and thiocyanate residuals from earlier tests are eluted by the NaOH rinse. Leave the column covered with the last rinse water for storage.

5. Calculation

Compute slope (m) and intercept (b) of standard curve as directed in 4500-CN⁻.E.5.

Calculate thiocyanate concentration as follows:

$$\text{mg SCN}^-/\text{L} = (ma_1 + b) \times \text{dilution factor}$$

where:

a_1 = absorbance of sample solution.

6. Precision and Bias[4]

a. Precision: Based on the results of twelve operators in nine laboratories, at four levels of concentration, the precision of the test method within its designated range is linear with concentration and may be expressed as follows:

Reagent water: $S_T = 0.093x + 0.0426$
$S_o = 0.045x + 0.010$

Water matrix: $S_T = 0.055x + 0.0679$
$S_o = 0.024x + 0.182$

where:

S_T = overall precision, mg/L,
S_o = pooled single-operator precision, mg/L, and
x = thiocyanate concentration, mg/L.

b. Bias: Recoveries of known amounts of thiocyanate from Type II reagent water and selected water matrices including natural waters, laboratory effluent, steel mill effluent, and dechlorinated and treated sanitary effluents were as follows:

Medium	Added *mg/L*	Recovered *mg/L*	*n*	S_T	Bias	% Bias
Reagent water	1.42	1.411	30	0.181	−0.009	−0.6
	0.71	0.683	27	0.091	−0.027	−4
	0.35	0.329	30	0.084	−0.021	−6
	0.07	0.068	30	0.052	−0.002	−3
Selected water matrices	1.42	1.408	26	0.151	−0.012	−0.8
	0.71	0.668	29	0.096	−0.042	−6
	0.35	0.320	29	0.085	−0.030	−9
	0.07	0.050	29	0.079	−0.020	−29

For other matrices these data may not apply.

7. References

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DRAFT

CH2M HILL
Montgomery Laboratory
Standard Operating Procedures
Wet Chemistry Department

Method for Total and Amenable Cyanide Analysis in Water

Method SW846 9010A and SW846 9012A (Manual Spectrophotometric; Semi-Automated Spectrophotometric)

1. SCOPE AND APPLICATION

1.1 This method applies to the determination of cyanide in drinking, surface and saline waters, and domestic and industrial wastes

1.2 The titration procedure using silver nitrate with p-dimethylaminobenzalrhodanine indicator is used for standardization of intermediate standard cyanide solution.

1.3 The manual colorimetric procedure is used for concentrations below 1 mg/L of cyanide and is sensitive to about 5 ug/L (Option A, 8.4).

2. SUMMARY OF METHOD

2.1 The cyanide as (HRN) hydrocyanic acid (HCN) is released from cyanide complexes by means of a reflux-distillation operation and adsorbed in a scrubber containing sodium hydroxide solution. The cyanide ion in the absorbing solution is then determined by volumetric titration or colorimetrically.

2.2 In the colorimetric measurement, the cyanide is converted to cyanogen chloride, CNCl, by reaction with chloramine-T at a pH less than 8 without hydrolyzing to the cyanate. After the reaction is complete, color forms upon the addition of pyridinebarbituric acid reagent. The absorbance is read at 578 nm for pyridine-barbituric acid. To obtain colors of comparable intensity, it is essential to have the same salt content in both the sample and the standards.

2.3 The titrimetric measurement uses a standard solution of silver nitrate to titrate cyanide in the presence of a silver sensitive indicator.

3. DEFINITIONS

3.1 Cyanide is defined as cyanide ion and complex cyanides converted to hydrocyanic acid (HCN) by reaction in a reflux system of a mineral acid in the presence of magnesium ion.

4. SAMPLE HANDLING AND PRESERVATION

4.1 All bottles must be thoroughly cleansed and rinsed to remove soluble material from containers.

4.2 Oxidizing agents such as chlorine decompose most of the cyanides. Test a drop of the sample with potassium iodide-starch test paper (KI-starch paper); a blue color indicates the need for treatment. Add ascorbic acid a few crystals at a time until a drop of sample produces no color on the indicator paper. Then add an additional 0.6 g of ascorbic acid for each liter of sample volume.

4.3 Samples are preserved with 2 ml of 10 N sodium hydroxide per liter of sample (ph $>$ 12) at the time of collection (Exhibit D, Section II).

4.4 Samples must be stored at 4°C (±2°C) and must be analyzed within the holding time specified in Exhibit D, Section II (14 days).

5. INTERFERENCES

5.1 Interferences are eliminated or reduced by using the distillation procedure described in Procedure 8.1.

5.2 Sulfides adversely affect the colorimetric and titration procedures. If a drop of the distillate on lead acetate test paper shows the presence of sulfides, treat 25 ml more of the sample than that required for the cyanide determination with powdered cadmium carbonate. Yellow cadmium sulfide precipitates if the sample contains sulfide. Repeat this operation until a drop of the treated sample solution does not darken the lead acetate test paper. Filter the solution through a dry filter paper into a dry beaker, and from the filtrate measure the sample to be used for analysis. Avoid a large excess of cadmium carbonate and a long contact time in order to minimize a loss by complexation or occlusion of cyanide on the precipitated material. Sulfides should be removed before the solution is preserved with sodium hydroxide as described in 4.3.

5.3 The presence of surfactants may cause the sample to foam during refluxing. If this occurs, adding an agent such as Dow Corning 544 antifoam agent will prevent the foam from collecting in the condenser. Fatty acids will distill and form soaps under alkaline titration conditions, making the end point almost impossible to detect. When this reaction occurs, one of the spectrophotometric methods should be used.

6. APPARATUS

6.1 Reflux distillation apparatus such as shown in Figure 1. The boiling flask should be 1 liter in size with an inlet tube and provision for a condenser.

6.2 Microburette, 5.0 ml (for titration)

6.3 Spectrophotometer suitable for measurements at 578 nm with a 1.0 cm cell or larger (for manual spectrophotometric method).

6.4 Lachat QuikChem Automated Flow Injection Analyzer which includes:

6.4.1 Automatic Sampler
6.4.2 Proportioning Pump
6.4.3 Injection Valve Module with a 150 cm 0.8 mm i.d. sample loop
6.4.4 Flow Cell, 10 mm, 80 uL
6.4.5 Interference Filter Wavelength, 570 nm
6.4.6 Heater Module
6.4.7 Reaction Module 10-204-00-1-A

7. REAGENTS

7.1 Distillation and Preparation Reagents

7.1.1 Sodium hydroxide solution 0.25N. Dissolve 20 g of NaOH in distilled water, and dilute to 2 liters with distilled water.

7.1.2 Cadmium carbonate: powdered

7.1.3 Ascorbic acid: crystals

7.1.4 Sulfuric acid: concentrated

7.1.5 Magnesium chloride solution: Weigh 510 g of $MgCl_2 \times 6H_2O$ into a 1,000 ml flask, dissolve, and dilute to 1 liter with distilled water.

7.1.6 Calcium hypochlorite solution: Dissolve 5 g of calcium hypochlorite [$Ca(OCl)_2$] in 100 ml of reagent water.

7.2 Stock Standards and Titration Reagents

7.2.1 Stock cyanide solution: Dissolve 2.51 g of KCN and 2 g KOH in 1 liter of distilled water. Standardize with 0.0192 N $AgNO_3$.

7.2.2 Standard cyanide solution, intermediate: Dilute 50.0 ml of stock (1 ml = 1 mg CN) to 1000 ml with distilled water.

Insert Figure 1

7.2.3 Standard silver nitrate solution, 0.0192 N: Prepare by crushing approximately 5 g $AgNO_3$ crystals and drying to constant weight at 40°C. Weigh out 3.2647 g of dried $AgNO_3$, dissolve it in distilled water, and dilute it to 1,000 ml (1 ml = 1 mg CN).

7.2.4 Rhodanine indicator: Dissolve 20 mg of p-dimethylaminobenzalrhodanine in 100 ml of acetone.

7.3 Manual Spectrophotometric Reagents

7.3.1 Sodium dihydrogenphosphate, 1 M: Dissolve 138 g of NaH_2PO_4 x H_2O in a liter of distilled water. Refrigerate this solution.

7.3.2 Chloramine-T solution: Dissolve 1.0 g of white, water soluble chloramine-T in 100 ml of distilled water and refrigerate until ready to use. Prepare fresh daily.

7.3.3 Color Reagent--

7.3.3.1 Pyridine-barbituric acid reagent: Place 15 g of barbituric acid in a 250 ml volumetric flask and add just enough distilled water to wash the sides of the flask and wet the barbituric acid. Add 75 ml of pyridine and mix. Add 15 ml of HCl (sp gr 1.19), mix, and cool to room temperature. Dilute to 250 ml with distilled water and mix. This reagent is stable for approximately 6 months if stored in a cool, dark place.

7.4 Semi-Automated Spectrophotometric Reagents

7.4.1 Chloramine-T solution: Dissolve 1.00 g of chloramine-T in distilled water and dilute to 100 mL. Prepare fresh daily.

7.4.2 Phosphate buffer: Dissolve 138 g of $NaH_2PO_4 \bullet H_2O$ in distilled water and dilute to 1 liter. Store at 4°C (±2°C).

7.4.3 Pyridine-barbituric acid solution: Transfer 15 g of barbituric acid into a 1 liter volumetric flask. Add about 100 mL of distilled water and swirl the flask. Add 74 mL of pyridine and mix. Add 15 mL of concentrated HCl and mix. Dilute to about 900 mL with distilled water and mix until the barbituric acid is dissolved. Dilute to 1 liter with distilled water. Store at 4°C (±2°C)

7.4.4 Sampler wash: Dissolve 10 g of NaOH in distilled water and dilute to 1 liter.

8. PROCEDURE

8.1 Pretreatment for cyanides amenable to chlorination:

8.1.1 Two sample aliquots are required to determine cyanides amenable to chlorination. To one 500-mL aliquot, or to a volume diluted to 500 mL, add calcium hypochlorite solution dropwise while agitating and maintaining the pH between 11 and 12 with sodium hydroxide (Step 5.3).

CAUTION: The initial reaction product of alkaline chlorination is the very toxic gas ***cyanogen chloride***; therefore, it is recommended that this reaction be performed in a hood. For convenience, the sample may be agitated in a 1-liter beaker by means of a magnetic stirring device.

8.1.2 Test for residual chlorine with KI-starch paper and maintain this excess for 1 hr, continuing agitation. A distinct blue color on the test paper indicates a sufficient chlorine level. If necessary, add additional hypochlorite solution.

8.1.3 After 1 hr, add 0.5 g portions of ascorbic acid until KI-starch paper shows no residual chlorine. Add an additional 0.5 g of ascorbic acid to ensure the presence of excess reducing agent.

8.1.4 Test for total cyanide in both the chlorinated and unchlorinated aliquots. (The difference of total cyanide in the chlorinated and unchlorinated aliquots is the cyanide amenable to chlorination.)

8.2 Distillation

8.2.1 Place 500 ml of sample, or an aliquot diluted to 500 ml, in the 1 liter boiling flask. Add exactly 100 ml of sodium hydroxide (7.1.1) to the absorbing tube. Connect the boiling flask, condenser, absorber, and trap in the train.

8.2.2 Start a slow stream of air entering the boiling flask by adjusting the vacuum source. Adjust the vacuum so that approximately one bubble of air per second enters the boiling flask through the air inlet tube.

NOTE: The bubble rate will not remain constant after the reagents have been added and while heat is being applied to the flask. It will be necessary to readjust the air rate occasionally to prevent the solution in the boiling flask from backing up into the air inlet tube.

8.2.3 Slowly add 25 ml concentrated sulfuric acid (7.1.4) through the air inlet tube. Rinse the tube with distilled water and allow the airflow to mix the flask contents for 3 minutes. Pour 20 ml of magnesium chloride solution (7.1.5) into the air inlet and wash it down with a stream of water.

8.2.4 Heat the solution to boiling, taking care to prevent the solution from backing up into and overflowing from the air inlet tube. Reflux for one hour. Turn off heat and continue the airflow for at least 15 minutes. After cooling the boiling flask, disconnect absorber and close off the vacuum source.

8.3 Titrimetric Determination for Standardization of Intermediate Standard Cyanide Solution

8.3.1 Transfer 100 ml of intermediate standard to a 500 ml Erlenmeyer flask. Add 10-12 drops of the benzalrhodanine indicator.

8.3.2 Titrate with standard silver nitrate to the first change in color from yellow to brownish-pink. Titrate a distilled water blank using the same amount of sodium hydroxide and indicator as in the standard.

8.3.3 The analyst should familiarize himself with the end point of the titration and the amount of indicator to be used before actually titrating the samples. A 5 or 10 ml microburette may be conveniently used to obtain a more precise titration.

8.4 Manual Spectrophotometric Determination (Option A)

8.4.1 Withdraw 50 ml or less of the solution from the absorbing tube and transfer to a 100 ml volumetric flask. If less than 50 ml is taken, dilute to 50 ml with 0.25 N sodium hydroxide solution. Add 15.0 ml of sodium phosphate solution (7.3.1) and mix.

8.4.1.1 Pyridine-barbituric acid method: Add 2 ml of chloramine-T (7.3.2) and mix., After 1 to 2 minutes, add 5 ml of pyridine-barbituric acid solution (7.3.3.1) and mix. Dilute to mark with distilled water and mix again. Allow 8 minutes for color development, then read absorbance at 578 nm in a 1 cm cell within 15 minutes.

8.4.2 Prepare a minimum of 5 standards and a blank by pipetting suitable volumes of standard solution into 100 ml volumetric flasks. NOTE: One calibration standard must be at the Contract Required Detection Limit (CRDL). To each standard, add 50 ml of 0.25 N sodium hydroxide. Standards must bracket the concentration of the samples. If dilution is required, use the blank solution.

As an example, standard solutions could be prepared as follows:

ul of Standard Solution 7.2.2	Conc. ug CN
0	Blank
50	2.5
100	5
200	10
500	25
1,000	50
2,000	100

8.4.2.2 It is not imperative that all standards be distilled in the same manner as the samples. At least one standard (mid-range) must be distilled and compared to similar values on the curve to ensure that the distillation technique is reliable. If the distilled standard does not agree with $\pm 15\%$ of the undistilled standards, the operator should find and correct the cause of the apparent error before proceeding.

8.4.2.2 Prepare a standard curve by plotting absorbance of standard vs. cyanide concentrations.

8.5 Semi-Automatic Spectrophotometric Determination (Option B)

8.5.1 Set up the manifold as shown in manifold diagram. Pump the reagents through the system until a steady baseline is obtained.

8.5.2 Calibration standards: Prepare a blank and at least five calibration standards over the range of the analysis. One calibration standard must be at the CRDL. For a working range of 0-100 ug/L, the following standards may be used:

8.5.2.1 It is not imperative that all standards be distilled in the same manner as the samples. At least one standard (mid-range) must be distilled and compared to similar values on the curve to ensure that the distillation technique is reliable. If the distilled standard does not agree within ± 15 percent of the undistilled standards, the operator should find and correct the cause of the apparent error before proceeding.

uL Standard Solution (7.2.2) diluted to 100 ml	Concentration ug CN/L
0	0
50	2.5
100	5.0
200	10.0
500	25.0
1,000	50.0
2,000	100.0

Add 1.0 g of NaOH to each standard. Store at 4°C (±2°C).

8.5.3 Place calibration standards, blanks, and control standards in the sampler tray, followed by distilled samples, distilled duplicates, distilled standards, distilled spikes, and distilled blanks.

8.5.4 Set Injection Timing With:

8.5.4.1	Pump speed: 35
8.5.4.2	Cycle period: 40 s
8.5.4.3	Sample Loop Length: 150 cm
8.5.4.4	Load period; 20 s
8.5.4.5	Inject period: 20 s
8.4.4.6	Inject to start of peak period: 25 s
8.4.4.7	Inject to end of peak period: 61 s

8.5.5 Set System IV Gain: 340 x 1

8.5.6 System operation

8.5.6.1 Inspect modules for proper connections.

8.5.6.2 Turn on power to all modules. Allow heater to warm up to 60°C.

8.5.6.3 Place reagent transmission lines into proper containers. Rain tension levers on pump tube cassettes.

8.5.6.4 Pump system until a stable baseline is attained.

8.5.6.5 Set baseline. If necessary, manually inject a high standard to set gain on colorimeter.

8.5.6.6 Program data system to initial parameters or those empirically determined.

8.5.6.7 Place calibration standards and blank in sample tray in descending order of concentration followed by unknowns, and check standards.

8.5.6.8 At end of run, place all transmission lines in water, flush system and pump dry.

8.5.6.9 Turn off pump, all modules, and release pump tube cassettes.

9. CALCULATIONS

9.1 Using the titrimetric procedure, calculate concentration of CN as follows:

$$\text{CN, mg/L} = \frac{(A-B)\ 1{,}000\ \text{ml/L}}{\text{ml orig. sample}} \times \frac{100\ \text{ml}}{\text{ml of aliquot titrated}}$$

where: A = volume of $AgNO_3$ for titration of sample (1 ml = 1 mg Ag)

B = volume of $AgNO_3$ for titration of blank (1 ml = 1 mg Ag)

AND: 100 ml = distillate volume (see 8.2.5)
1,000 ml = conversion ml to L
ml original sample (See 8.2.1)
ml of aliquot titrated (See 8.3.1)

Manifold Diagram

CARRIER is 0.25 M sodium hydroxide, Reagent 1.

1"	is	**70.0**	cm of tubing on a 1 in coil support
2"	is	**135**	cm of tubing on a 2 in coil support
2.5"	is	**168**	cm of tubing on a 2.5 in coil support
3"	is	**202**	cm of tubing on a 3 in coil support
4"	is	**255**	cm of tubing on a 4 in coil support
8"	is	**550**	cm of tubing on a 8 in coil support

Heated tubing is shown inside a box with the temperature next to the box. heated tubing is **650** cm unless otherwise specified.

All manifold tubing is **0.8** mm (0.032 in) i.d. This is 5.2 uL/cm.

10.0 QUALITY CONTROL

10.1 Verify calibration with an independent calibration standard (EPA traceable). If the standards are not within 15% of the expected value, recalibration is required. Verify calibration at the beginning of the analysis (initial calibration verification–ICV) and every 10 analysis (continuing calibration verification–CCV).

10.2 A matrix spike should be prepared to check the efficiency of sample distillation by adding cyanide from the intermediate standard to 500 mL of sample to ensure a concentration of approximately 40 μg/L. Both the matrix duplicate and matrix spike duplicate are brought through the entire sample preparation and analytical process.

10.3 The method of standard additions can be used for the analysis of all samples that suffer from matrix interferences.

10.4 Standard curve will be derived from data consisting of one reagent blank and all the concentrations of standards. The response for each prepared standard shall be based upon the average of three replicate readings of each standard.

10.5 Standard curve must be verified with a standard within $\pm$10% of true value.

10.6 A reagent blank must be run at the beginning of analysis (initial calibration blank–ICB), and with every 10 analysis (continuing calibration blank–CCB)).

10.7 A method blank will be distilled and analyzed with each sample distillation batch. If the method blank result is not below the reporting limit, the batch must be redistilled and reanalyzed.

10.8 A laboratory control sample (EPA traceable) will be distilled and analyzed with the sample distillation batch. If the laboratory control sample result is not within $\pm$15% of true value, the batch must be redistilled and reanalyzed.

10.9 A high and a low standard that is distilled must be analyzed with each analysis batch with results within $\pm$10% of true value.

10.10 Sample matrix interference caused by sulfides and chlorides should be removed before preservation and distillation.

4500-CN⁻ I. Weak Acid Dissociable Cyanide

1. General Discussion

Hydrogen cyanide (HCN) is liberated from a slightly acidified (pH 4.5 to 6.0) sample under the prescribed distillation conditions. The method does not recover CN^- from tight complexes that would not be amenable to oxidation by chlorine. The acetate buffer used contains zinc salts to precipitate iron cyanide as a further assurance of the selectivity of the method. In other respects the method is similar to 4500-CN⁻.C.

2. Interferences

See 4500-CN⁻.B.3.

Protect sample and apparatus from ultraviolet light to prevent photodecomposition of some metal-cyanide complexes and an increase in concentration of weak acid dissociable cyanide.

If procedure is used to determine low concentrations of cyanide in samples of ferri- and ferrocyanide, add more, e.g., fivefold excess, zinc acetate solution before adding acid and distilling.

3. Apparatus

See Section 4500-CN⁻.C.2 and Figure 4500-CN⁻:1, and also Section 4500-CN⁻.D.2, 4500-CN⁻.E.2, or 4500-CN⁻.F.2, depending on method of estimation.

4. Reagents

a. Reagents listed in Section 4500-CN⁻.C.3.

b. Reagents listed in Section 4500-CN⁻.D.3, 4500-CN⁻.E.3, or 4500-CN⁻.F.3, depending on method of estimation.

c. Acetic acid, 1 + 9: Mix 1 volume of glacial acetic acid with 9 volumes of water.

d. Acetate buffer: Dissolve 410 g sodium acetate trihydrate ($NaC_2H_3O_2 \cdot 3H_2O$) in 500 mL water. Add glacial acetic acid to yield a solution pH of 4.5 (approximately 500 mL).

e. Zinc acetate solution, 100 g/L: Dissolve 120 g $Zn(C_2H_3O_2)_2 \cdot H_2O$ in 500 mL water. Dilute to 1 L.

f. Methyl red indicator.

5. Procedure

Follow procedure described in 4500-CN⁻.C.4, but with the following modifications:

a. Do not add sulfamic acid, because NO_2^- and NO_3^- do not interfere.

b. Instead of H_2SO_4 and $MgCl_2$ reagents, add 20 mL each of the acetate buffer and zinc acetate solutions through air inlet tube. Also add 2 to 3 drops methyl red indicator. Rinse air inlet tube with water and let air mix contents. If the solution is not pink, add acetic acid (1 + 9) dropwise through air inlet tube until a pink color persists.

c. Follow instructions beginning with 4500-CN⁻.C.4*d*.

d. For determining CN^- in the absorption solution, use the preferred finish method (4500-CN⁻.D, E, or F).

6. Precision and Bias[1]

The precision and bias information given in this section may not apply to waters of untested matrices.

a. Precision:

1) Colorimetric—Based on the results of nine operators in nine laboratories, the overall and single-operator precision of this test method within its designated range may be expressed as follows:

$$\text{Reagent water: } S_T = 0.09x + 0.010$$
$$S_o = 0.08x + 0.005$$

$$\text{Selected water matrices: } S_T = 0.08x + 0.012$$
$$S_o = 0.05x + 0.008$$

2) Electrode—Based on the results of six operators in five laboratories, the overall and single-operator precision of this test method within its designated range may be expressed as follows:

$$\text{Reagent water: } S_T = 0.09x + 0.004$$
$$S_o = 0.02x - 0.009$$

$$\text{Selected water matrices: } S_T = 0.08x + 0.005$$
$$S_o = 0.02x + 0.004$$

3) Titrimetric—Based on the results of six operators in three laboratories, the overall and single-operator precision of this test method within its designated range may be expressed as follows:

$$\text{Reagent water: } S_T = 0.532 - 0.10x$$
$$S_o = 0.151 - 0.01x$$

$$\text{Selected water matrices: } S_T = 0.604 - 0.06x$$
$$S_o = 0.092 + 0.02x$$

where:

S_T = overall precision,
S_o = single-operator precision, and
x = cyanide concentration, mg/L.

b. Bias: Recoveries of known amounts of cyanide from Type II reagent water and selected water matrices are shown below.

Medium	Technique	Added *mg/L*	Recovered *mg/L*	*n*	S_T	Bias	% Bias
Reagent water	Colorimetric	0.030	0.030	25	0.0089	0.000	0
		0.100	0.117	27	0.0251	0.017	17
		0.400	0.361	27	0.0400	−0.039	−10
	Electrode	0.030	0.030	21	0.0059	0.000	0
		0.100	0.095	21	0.0163	−0.005	−5
		0.400	0.365	21	0.0316	−0.035	−9
		1.000	0.940	21	0.0903	−0.060	−6
	Titrimetric	1.00	1.35	18	0.4348	0.35	35
		1.00	1.38	18	0.3688	0.38	38
		4.00	3.67	18	0.1830	−0.33	−8
Selected water matrices	Colorimetric	0.030	0.029	15	0.0062	0.001	3
		0.100	0.118	24	0.0312	0.018	18
		0.400	0.381	23	0.0389	−0.019	−5
	Electrode	0.030	0.029	20	0.0048	−0.001	−3
		0.100	0.104	21	0.0125	0.004	4
		0.400	0.357	21	0.0372	−0.043	−11
		1.000	0.935	21	0.0739	−0.065	−7
	Titrimetric	1.00	1.55	18	0.5466	0.55	55
		1.00	1.53	18	0.4625	0.53	53
		4.00	3.90	18	0.3513	−0.10	−3

7. Reference

1. AMERICAN SOCIETY FOR TESTING & MATERIALS. 1987. Research Rep. D2036:19-1131. American Soc. Testing & Materials. Philadelphia. Pa.

Appendix L

HydroPunch Method

HYDROPUNCH

Site Investigation Without Wells

The HydroPunch® system enables drill rig operators to locate, measure and sample ground water and floating layers of gasoline and other hydrocarbons—rapidly and economically, without installing wells.

HydroPunch Collects Samples of Ground Water & Floating Layer

QUALITY SAMPLES IN AN HOUR OR LESS—AT MUCH LOWER COST

HydroPunch technology is a breakthrough in site investigation. Sampling is so rapid, you can have *reliable data in hours*, not the weeks or months required by traditional monitoring well surveys. Unlike geophysical or soil gas techniques, HydroPunch delivers actual samples of ground water and hydrocarbons—not indirect and sometimes misleading readings.

HydroPunch samples are consistent with monitoring requirements *for all priority pollutants.* HydroPunch II hydrocarbon samples accurately identify and show relative thickness of floating layers.

Best yet, HydroPunch sampling costs 50-90% less than drilling, casing, and developing conventional monitoring wells. HydroPunch sampling is not intended to replace wells for long-term monitoring; it helps optimize location and minimize the number of wells needed for effective monitoring—greatly speeding up site assessment.

ENVIRONMENTALLY SAFE, WITH NO PERMANENT INSTALLATION

HydroPunch operates with minimal disturbance to environmentally sensitive areas. There's no need to dispose of well development water, or of drill cuttings when pushed directly from the surface. The unobtrusive technique won't interfere with normal site operations.

HydroPunch boreholes can be easily abandoned or pressure-grouted from the bottom up. This leaves no permanent well to be monitored unnecessarily, and helps protect against possible short-circuiting of contamination between vertical zones.

HYDROPUNCH

HOW IT WORKS

The HydroPunch is driven to the desired depth in unconsolidated soils. The HydroPunch system can be used in formations suitable for a standard 2" split barrel (spoon) soil sampler—such as unconsolidated clays, silts, sands, and fine gravels.

Preliminary borings, an initial site test sample, or other information helps estimate sampling depth. An auger or split barrel sampler may provide a "pilot hole" to the area just above the sampling zone. (In some conditions, the tool can be driven directly from the surface for faster sampling.)

HYDROPUNCH I—GROUND WATER SAMPLING

The sampling tool is assembled with clean O-rings, screens, and check balls. With the drive cone/inlet assembly retracted, the tool is driven to the proper depth—at least 5 feet below the static water level, to allow sufficient hydrostatic pressure for the sample chamber to fill.

The tool is pulled back approximately 12", exposing the screened sample zone and isolating the collection point from layers above and below. After filling (time varies according to submergence and formation yield), the whole HydroPunch is withdrawn to the surface, where 500 ml of sample is discharged through a stopcock.

HYDROPUNCH II—GROUND WATER SAMPLING

Check valves, stainless steel screen, and O-rings are inserted in the tool body (HPII), then the replaceable point is attached. The tool is driven to the proper depth and pulled back approximately 18". After filling, the tool is withdrawn to discharge 1250 ml of sample, leaving the steel point in the ground.

HYDROPUNCH II—FLOATING LAYER SAMPLING

After inserting the replaceable polypropylene or PVC screen and attaching the point, the tool is driven to the proper depth. It is then withdrawn about 48", and a 1" O.D. hydrocarbon bailer is lowered through the hollow casing to provide the floating layer thickness estimate and sample.

HYDROPUNCH OR HYDROPUNCH II:

How To Choose

For most applications, the HydroPunch II (patent pending) will probably be the tool of choice. It is more rugged, simpler to operate, samples hydrocarbons as well as ground water, delivers a larger sample volume, and costs no more.

The original HydroPunch (U.S. Patent No. 4,669,554) will be the choice when it is not permissible to leave expendable drive cones (and/or screens) in the ground, or when the tool is to be driven by cone penetrometer equipment rather than a drill rig.

HYDROPUNCH I

- **Collects ground water samples only (not floating layer)**
- **Permanently-attached drive cone and screen (leaves nothing in the ground)**
- **Can be used with cone penetrometer or drill rig**
- **Expendable supplies (O-rings, screens, clamps) sold separately**

HYDROPUNCH II

- **Collects floating layer *and* ground water samples**
- **Replaceable cones and screens are left in ground (note: screens may be retrievable)**
- **Stronger for tough duty; used with drill rig**
- **Expendable supplies (points, screens, O-rings) sold separately**

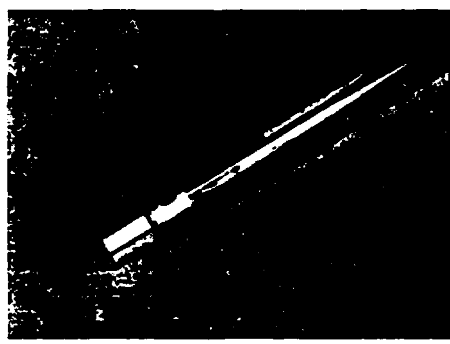
HYDROPUNCH ON VIDEO

Sampling Ground Water And Hydrocarbons Without Wells

This 15-minute tape shows how the HydroPunch system collects ground water and floating hydrocarbon samples for field investigation and plume definition without installing permanent wells, with 50-90% savings in cost and time. Economics, speed, and accuracy are explored with animation, graphics, and interviews with consultants, drillers, and industrial end users, explaining the advantages of this new technology.

HydroPunch II User's Guide

This easy-to-use video, included with every HP1000 kit, provides detailed, step-by-step instructions covering all aspects of HydroPunch II use. Major areas include: how the system works; assembly and operation in both ground water and hydrocarbon sampling modes; decontamination procedures; drillers' rules; and field trouble-shooting techniques.



Hydrocarbon bailer for floating layer sampling with HydroPunch II (or in wells).

HydroPunch II expendable screens—(left to right) PVC and standard polypropylene for floating layers, stainless steel for ground water.

HYDROPUNCH

HYDROPUNCH I

SPECIFICATIONS:

O.D.: 1.75
Length: 64.50" (closed)
Top thread: AW box
Weight: 24 lbs.
Sample volume: 500 ml
Materials:
- Body & fittings: 304 S.S.
- Check balls: S.S.
- Screen: S.S.
- Barbed point: S.S.
- Stopcock: Teflon®
- Discharge tubing: Teflon
- O-rings: Viton

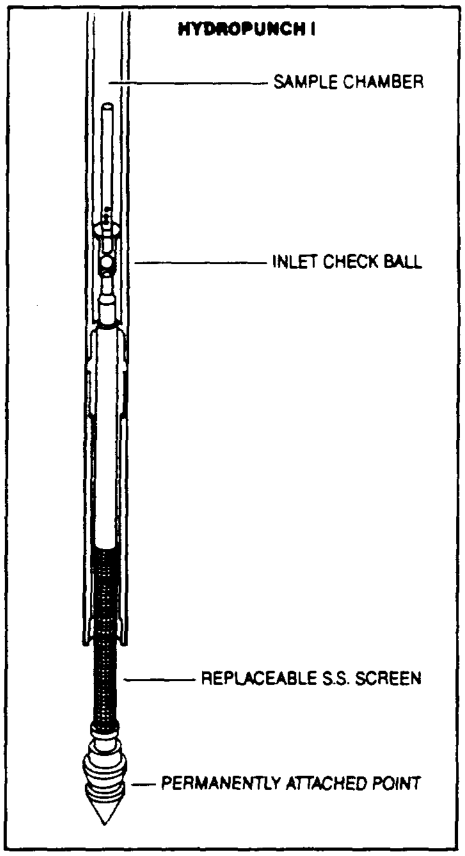
SYSTEM COMPONENTS:

MODEL NO.	DESCRIPTION
HP0500	HydroPunch Kit—Includes HydroPunch w/ barbed point; cleaning brush & handle set; top discharge w/ Teflon stopcock & tubing; 12 extra O-ring sets, 12 S.S. screen sets, and check balls; instruction book; carrying case.
35500	Basic HydroPunch without case or accessories

OPERATING SUPPLIES:

(One set of each per drive)

35540	O-ring Kit—12 sets
35760	Screen Kit—12 screens w/ clamps

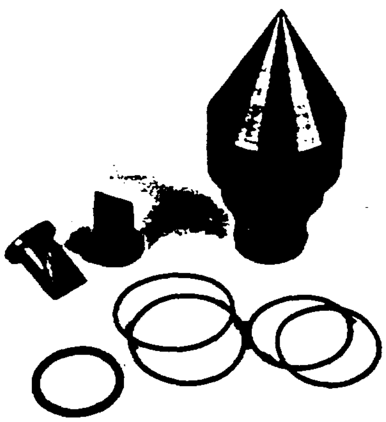


HYDROPUNCH II

SPECIFICATIONS:

O.D.: 2.00"
Length: 60" (closed)
Top thread: AW Box and EW Casing
Weight: 26 lbs. (ground water mode)
24 lbs. (hydrocarbon mode)
Sample volume: 1250 ml (ground water mode)
Unlimited (floating layer)
Materials:
- Body & fittings: 304 S.S.
- Drive shoes: Carbon Steel (S.S. optional)
- Adaptors: Carbon Steel
- Check valves: Ethylenepropylene
- Screens: S.S. (ground water), Polypropylene or PVC (hydrocarbon)

Points: Lead-free Carbon Steel
O-rings: Viton
Stopcock: Teflon
Discharge tubing: Teflon



® Teflon is a registered trademark of E.I duPont De Nemours Company, Inc.

SYSTEM COMPONENTS:

MODEL NO.	DESCRIPTION
HP1000	HydroPunch II Kit—Includes HPII; cleaning brush & handle set; top discharge w/ Teflon stopcock & tubing; hydrocarbon bailer; 5 sets check valves (reusable); 10 sets O-rings; instruction book; how-to-use video; carrying case. (Does not include points & screens).
36047	Basic HydroPunch II without case or accessories

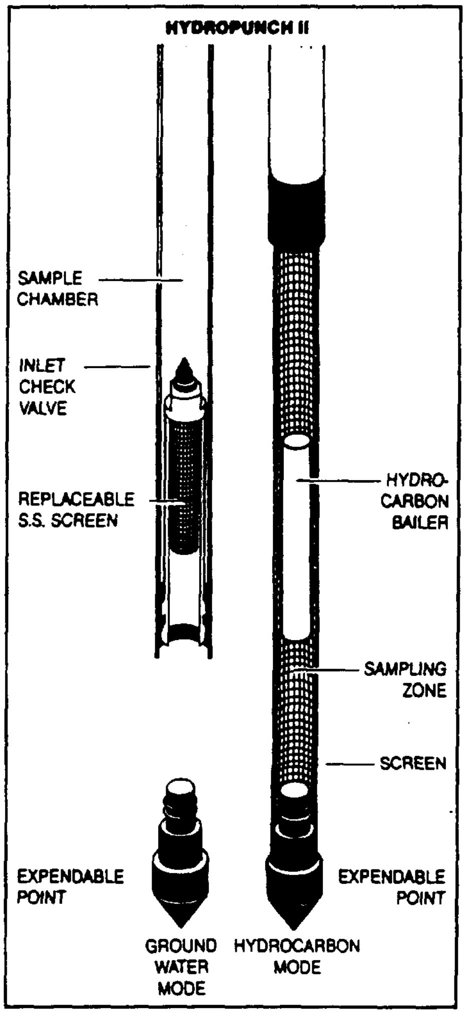
OPERATING SUPPLIES:

(One each per drive in appropriate mode)

Both modes:	
36050	Drive Point Kit—10 ea.
36049	O-ring Kit—10 sets
Ground Water mode:	
36051	S.S.Screen Kit (4" length)—10 ea.
Hydrocarbon mode: (choice of)	
36102	Standard Polypropylene Screen Kit (5' length. 0.40" slot)—10 ea.
36103	PVC Screen Kit (5' length, .010" slot)—10 ea.

ACCESSORIES:

35509	1" O.D. Teflon Bailer
36164	1" O.D. Hydrocarbon Bailer
8340100	Bailer Reel w/ 100' Cable
36106	Sub AW Box—EW Casing
36107	EW Casing, 5' length
36171	EW Casing, 2' length
36172	EW Casing, 3' length
36173	Sub EW Pin—NWML Box



Appendix M

Surface Water Sampling Standard Operating Procedures

APPENDIX M-1

STANDARD OPERATING PROCEDURE FOR SOUNDING DEPTHS

A Hummingbird Depth Sounder will be used for sounding depths at surface water sampling locations. The Hummingbird Depth Sounder does not require calibration. To determine the depth of water at a location:

1. Attach the sounding device to the boat. Orient the device so that it is perpendicular to the bottom of the water body.

2. Turn the device on and record the depth as it appears on the instrument.

APPENDIX M-2

STANDARD OPERATING PROCEDURE FOR RETRIEVING SURFACE WATER SAMPLES FROM DEPTH WITH A KEMMERER BOTTLE

The Kemmerer bottle is a messenger-activated water sampling device. In the open position water flows easily through the device. Once lowered to the desired depth a messenger is dropped down the sample line tripping the release mechanism and closing the bottle. In the closed position, the bottle is sealed, both top and bottom, from any additional contact with the water column and can be retrieved. A stainless steel and teflon Kemmerer bottle will be used for collecting surface water samples from depth.

Procedure

1. Measure and then mark sample line at desired sampling depth.

2. Open bottle by lifting top stopper-trip head assembly.

3. Place messenger on sample line and release.

4. Retrieve sampler; hold sampler by center stem to prevent accidental opening of bottom stopper.

5. Recover sample by grasping lower stopper and sampler body with one hand, and transfer sample by either lifting the top stopper with the other hand and carefully pouring contents into sample bottle, or holding drain valve (if present) over sample bottle and opening valve.